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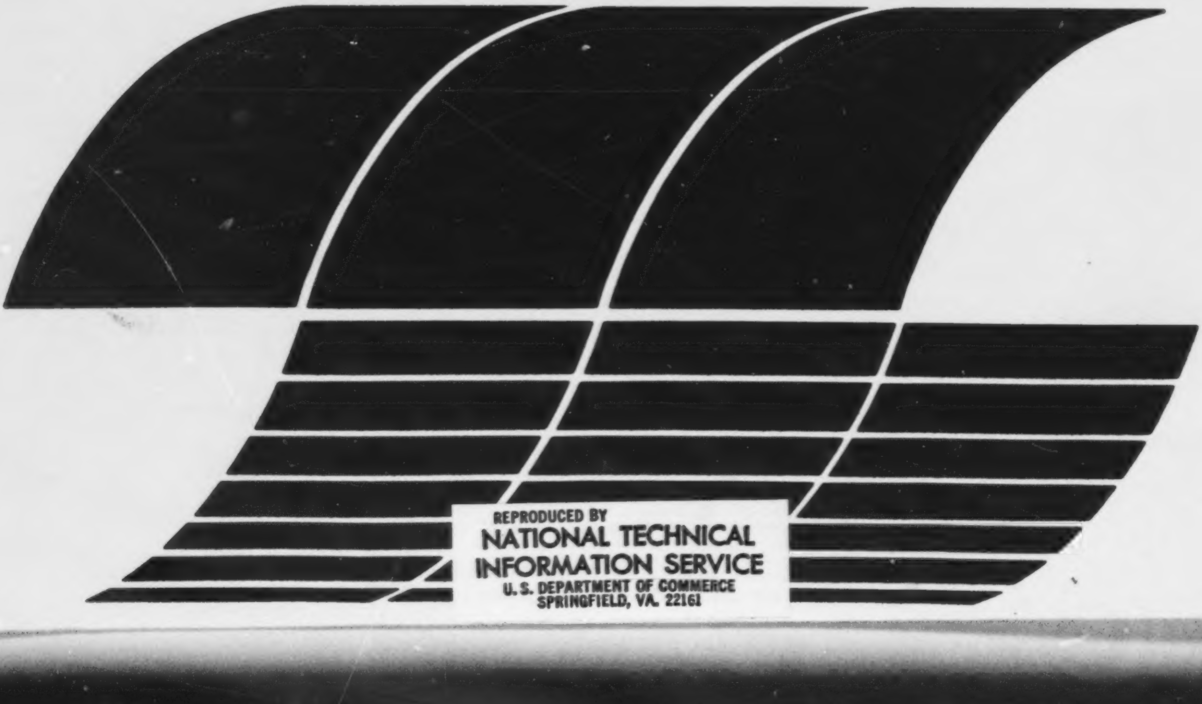

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16. ABSTRACT The report gives results of a Level 1 data evaluation and prioritization and the Level 2 environmental assessment (EA) chemical data acquired on a set of fluidized-bed combustor (FBC) particulate samples. The Level 2 analysis followed the approach described in 'Approach to Level 2 Analysis Based on Level 1 Results,' a companion report. The report demonstrates the utility of the decision criteria based on Multimedia Environmental Goal (MEG) compounds at Minimum Acute Toxicity Effluent (MATE) concentrations. It assesses the Level 1 FBC data through their presentation on the Level 1 Data Reduction and Decision Charts: the assessment results in a list of inorganic and organic compounds which are specifically sought in the Level 2 chamical analyses. The data generated from the integrated approach to Level 2 inorganic compound analysis is detailed, with the raw data appended. This Level 2 inorganic effort was qualitative and quantitative, with oxidation states and compound identification established. The organic Level 2 analytical work is based on gas chromatography/mass spectrometry and resulted in various aromatic and aliphatic hydrocarbons quantitated and identified in the FBC emission samples.

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Assessments	Inorganic Compounds	Stationary Sources	14B	
Chemical Analysis		Environmental Assessment	07D	07B
Sampling	Organic Compounds			07C
Fluidized-Bed Processing		Particulate	13H,07A	
Combustion		MEGs	21B	
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Level 2 Chemical Analysis of Fluidized-Bed Combustor Samples

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ABSTRACT

This report has been prepared as a requirement of Contract 68-01-3152, Tasks 2, 3 and 4 to document the Level 2 chemical data acquired on a set of Fluidized Bed Combustor (FBC) particulate samples collected by Battelle Columbus Laboratory. The Level 2 analytical effort followed the approach described in the companion document "Approach to Level 2 Analysis Based on Level 1 Results, MEG Categories and Compounds and Decision Criteria" (1). The companion document should be available to the reader when reviewing this analytical volume. It contains the necessary technical explanations of the analytical techniques employed and will be referred to throughout this report as "the reference text".

Battelle Columbus Laboratory had collected and analyzed by a modification of the Level 1 Environmental Assessment protocol a set of FBC particulate samples. These were run No. 2 of 6" FBC unit, Level 1 report dated September 22, 1976 under EPA Contract No. 68-02-1409, Task No. 33. These samples were retained for Level 2 analyses. This report uses the Level 1 data to prioritize the Level 2 effort (Section 2) and conducts level 2 inorganic (Section 3) and organic (Section 4) analytical efforts as described in the reference text.

Section 2 of this document demonstrates the utility of the decision criteria based on Multimedia Environmental Goal (MEG) compounds at Minimum Acute Toxicity Effluent (MATE) concentrations. It assesses the modified Level 1 data through their presentation on the "Level 1 Data Reduction and Decision Charts". This results in a list of inorganic elements, ions and compounds and organic compounds which are specifically sought for in the inorganic and organic Level 2 efforts. Because the samples were not taken, stored and/or analyzed by the established Level 1 procedures, the Level 1 information is incomplete; however, the information obtained has been used as a first cut evaluation of the Level 1 to Level 2 process for the selection of specific samples for Level 2 characterization.

Section 3 reports the data generated from the integrated approach to Level 2 inorganic compound analysis. The detailed logic networks presented

in the reference text have been followed and their utility demonstrated. In the Initial Sample Characterization Phase, where elemental composition, sample stability and bulk morphological structure were determined; the FBC samples were found to be:

- Highly stable and mostly inorganic in composition.
- Relatively uniform in morphology and without optically identifiable crystalline materials.
- Flame and flameless atomic absorption spectrometry adequately established cation quantities.

The Bulk Composition Characterization for this Level 2 inorganic effort was qualitative. Oxidation states and compound identification were established. After this analytical phase the FBC samples were known to contain the following compounds as major constituents:

- Fe_2O_3, SiO_2, $CaSO_4 \cdot 2H_2O$, $CaSO_4 \cdot 1/2\ H_2O$, $CaSO_4$ (anhydrous), CaS, CaO and $CaCO_3$ (vaterite and calcite forms).

The next phase of Individual Particle Characterization confirmed the prior analytical findings of uniformity and composition. However, it also identified submicron particles of SiO_2 which were present as discrete, respirable crystallites.

The organic Level 2 analytical work is reported in Section 4. The gas chromatography/mass spectrometric (GC/MS) work resulted in various aromatic and aliphatic hydrocarbons being quantitated and identified as present in the FBC emission samples.

Table I summarizes the organic analytical results obtained from this Level 1 data assessment and Level 2 chemical analyses; Table II summarizes the inorganic.

Appendices A through D and F contain raw data, calibration curves and actual spectral scans. Appendix E reports a repeat Level 1 organic analysis on the FBC samples.

Table I. Organic Summary

LEVEL 1 ASSESSMENT			LEVEL 2 DATA			
Level 1 Organic Liquid Chromatographic (LC) Fraction Requiring Level 2 Analysis	MEG Categories Sought In Level 2		MEG Compounds Identified		µg/m^3 Concentration	
	Probable Category	µg/m^3 Concentrations*	MEG Category	MEG Compound	PER Compound	Total PER LC Fractions
LC 1	Organometallics	7.6×10^2	Aliphatic Hydrocarbons	Alkanes (C > 9)	1.9×10^3	1.9×10^3
LC 2 and 3	Unsaturated Alkyl Halides	1.3×10^3	Aliphatic Hydrocarbons	Alkanes (C > 9)	7.7×10^2	
	Halogenerated		Esters	Phthalates**	1.2×10^2	
	Aromatic Hydrocarbons		Fused Aromatic Hydrocarbons	1,2 Benzanthracene	2.8×10	
	Benzene, Substitute			Phenanthrene	1.7×10^2	1.5×10^3
	Benzene			Methyl Anthracene	1.2×10^2	
	Fused Aromatic Hydrocarbons			Pyrene	3.5×10	
				Naphthalene	1.5×10	
	Fused Nonalternate Polycyclic Hydrocarbons		Fused Nonalternate Polycyclic Hydrocarbons	Benzo Fluoranthene Fluoranthene	1.9×10	
LC 4 and 5	Heterocyclic Sulfur	6.6×10^2	Esters	Phthalates**	2.1×10^3	2.1×10^3
LC 6 and 7	Amines	1.2×10^3	Esters	Phthalates**	8.7×10^2	
	Mercaptans, Sulfides		Unknown (1)	Molecular Weight 176		
	Halophenols				2.4×10^2	2.0×10^3
	Nitrophenols		Unknown (2)	Hydrocarbons Molecular Weight 394		
	Heterocyclic					
	Nitrogen				8.7×10^2	

*These are the concentrations determined by the Level 1 analytical effort.

**Only compound which EXCEEDS MATES

Table II. Inorganic Summary

	LEVEL 1 ASSESSMENT MEG Compounds Sought In Level 2		LEVEL 2 DATA	
Inorganic MEG Category Requiring Level 2 Analyses	Probable Compound	µg/m^3 Concentration*	MEG Compounds Identified (Indicated)	µg/m^3 Concentration
Lithium	Li, Li^+, Li_2CO_3	2.3×10^2	Li, Li^+	6.3×10^2 EXCEEDS MATE
Sodium	Na^+	5.7×10^4	Na^+, (Na_2O)	5.4×10^5 EXCEEDS MATE
Potassium	K^+	2.6×10^5	K^+	6.7×10^4
Beryllium	Be^{++}, BeO, $BeO \cdot Al_2O_3 \cdot SiO_2$	4.1	none detected	
Magnesium	Mg^{++}, MgO, $MgSO_4$, $MgCO_3$, $MgCO_3 \cdot CaCO_3$	9.8×10^4	(MgO), Mg^{++}, ($MgSO_4$)	7.3×10^4 (as Mg) EXCEEDS MATE
Calcium	Ca^{++}, $CaCO_3$, $CaSO_4$	1.3×10^6	Ca^{++}, $CaCO_3$, $CaSO_4$, CaS, (CaO)	9.5×10^5 (as Ca) EXCEEDS MATE
Strontium	Sr^{++}, $SrSO_4$	4.3×10^3	Sr^{++}, ($SrSO_4$)	1.4×10^4 (as Sr) EXCEEDS MATE
Barium	Ba, $BaCO_3$, $BaSO_4$	1.6×10^4	none detected	
Aluminum	Al^{+3}, Al_2O_3, $Al_2O_3 \cdot 3H_2O$	9.4×10^6	Al^{+3}, (Al_2O_3)	5.2×10^4 (as Al) EXCEEDS MATE
Thallium	Tl	1.6×10^2	none detected	
Silicon	SiO_4^{-2}, SiO_3^{-2}, SiO_2, SiC	3.5×10^6	Si, (SiO_3^{-2}), SiO_2	1.3×10^2 (as Si) EXCEEDS MATE
Lead	Pb^{+2}, Pb^{+4}, PbO, $PbSO_4$, $PbCO_3$, $Pb_3(PO_4)_2$	9.5×10^2	Pb^{+2}, ($PbSO_4$, $PbCO_3$)	3.3×10^3 (as Pb) EXCEEDS MATE
Nitrogen	NO_3^-, NO_2^-	1.8×10^5	(NO_3^-, NO_2^-)	not determined
Phosphorus	PO_3^{-3}, PO_4^{-3}	1.1×10^3	not detected	
Arsenic	As^{+3}, As^{+5}, AsO_4^{-3}, AsO_3^{-3}, As_2O_3	2.3×10^1	As, (AsO_4^{-3}, As_2O_3)	5.0×10^{-1} (as As)
Sulfur	S^{-2}, SO_4^{-2}, SO_3^{-2}	2.2×10^4	S^{-2}, SO_4^{-2}, SO_3^{-2}	not determined
Yitrium	Y^{+3}	8.5×10^3	none detected	
Titanium	Ti^{+3}, Ti^{+4}, TiO_2	2.7×10^4	none detected	
Zirconium	Zr^{+4}, ZrO_2	3.5×10^3	Zr^{+4}, (ZrO_2)	2.0×10^1 (as Zr)
Vanadium	V^{+3}, VO^{+2}, VO_4^{-4}, VO_3, VO^{+3}, VO, V_2O_3, V_2O_4, V_2O_5, $VOSO_4 \cdot 5H_2O$	9.8×10^3	V, (VO_4^{-4}, V_2O_3, V_2O_4, V_2O_5, $VOSO_4 \cdot 5H_2O$)	2.6×10^3 (as V) EXCEEDS MATE
Chromium	Cr^{+2}, Cr^{+3}, CrO_4^{-2}, $Cr_2O_7^{-2}$, Cr_2O_3, FeO Cr_2O_3, $FeCrO_4$	2.1×10^3	Cr, Cr^{+2}, Cr^{+3}, (CrO_4^{-2}, $Cr_2O_4^{-2}$, Cr_2S_3, CrO_3)	8.3×10^3 (as Cr) EXCEEDS MATE
Maganese	Mn^{+2}, Mn^{+3}, MnO_4, MnO, MnO_2, $MnCO_3$, $MnSO_4$	3.8×10^3	Mn^{+2}, Mn^{+3}, (MnO_4, MnO_2, $MnCO_3$, $MnSO_4$)	1.3×10^2 (as Mn)
Iron	Fe^{+2}, Fe^{+3}, $FeO \cdot Fe_2O_3$, FeS, Fe_2O_3, $KFeSi_2O_6$	4.3×10^5	Fe^{+3}, Fe_2O_3, (FeS)	5.6×10^2 (as Fe)
Cobalt	CO^{+2}, Co^{+3}, $CoCo_3 \cdot 4H_2O$, CoO	1.9×10^2	none detected	
Rhodium	Rh^{+3}	2.1×10^2	none detected	
Kickel	Ni^{+2}, Ni^{+3}, NiO	3.8×10^3	none detected	
Copper	Cu^+, Cu^{+2}, CuO, Cu_2O, $CuSO_4$, $CuCO_3$	9.7×10^2	Cu^+, Cu^{+2}, (CuO, $CuSO_4$, $CuCO_3$)	4.6×10^1 (as Cu)
Cadmium	Cd^{+2}, CdO	$< 6.0 \times 10^1$	Cd	5.0 (as Cd)
Uranium	U	6.4×10^1	not determined	
Silver	not required		Ag	3.9×10^2 (as Ag) EXCEEDS MATE
Zinc	not required		Zn, (ZnO, $ZnSO_4$, ZnS)	6.6×10^3 (as Zn) EXCEEDS MATE
Mercury	not required		Hg	9.3×10^2 (as Hg) EXCEEDS MATE

*These are the concentrations determined by the Level 1 SSMS. The SSMS Level 1 data are not expected to be accurate for major components (>100 ppm, $>5 \times 10^4$ µg/m3).

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1. INTRODUCTION

In the phased approach to environmental assessment, Level 1 is the initial survey method by which hazardous streams are distinguished from those less hazardous or innocuous. Level 1 sampling and analysis have been designed to generate semiquantitative (±3X) information about the organic and inorganic species of interest in the sampled stream so that a dominant offender does not go undetected. The degree of characterization that Level 1 provides consists of identifying organic classes of compounds and inorganic elements. This information can then be used to prioritize the detailed and specific analysis required in Level 2. Level 2 analysis seeks compound identification and may have higher accuracy requirements than Level 1.

The decision criteria developed in the companion document, "Approach to Level 2 Analysis Based on Level 1 Results, MEG Categories and Compounds and Decision Criteria" (1), has been used here in prioritizing and proceeding to a Level 2 emission characterization on Fluidized Bed Combustor (FBC) particulate samples.

A Level 2 analysis was then conducted. In many cases this was the first application for some techniques to environmental samples. This Level 2 analysis has generated qualitative and quantitative compound information based on the analytical schemes developed and presented in the reference text. Although compound information has been generated for the FBC samples analyzed, this should be viewed as a preliminary Level 2 environmental assessment. Many of the techniques employed were developmental and would require greater experimental efforts to optimize and refine these qualitative methods into quantitative ones. This work will be evolving as more Level 2 analytical efforts are undertaken and a greater bank of knowledge is obtained on the behavior of environmental samples undergoing chemical analyses.

The work presented here was used to modify the reference text and did provide many insights into sample preparation and analytical technique utility. The reference text has been edited to reflect the knowledge gained from each phase of this analytical effort.

This document is based on currently available MEG and MATE values and state-of-the-art analytical methodologies.

2. BATTELLE FLUIDIZED BED COMBUSTOR LEVEL 1 DATA AND RESULTING LEVEL 2 PLAN

The Battelle modified Level 1 data from run No. 2 of the 6-inch fluidized bed combustor unit were reported on September 22, 1976, under EPA Contract No. 68-02-1409, Task No. 33. TRW assessed these analytical results according to the Level 1 - Level 2 transition presented in the "Approach to Level 2 Analysis Based on Level 1 Results, MEG Categories and Compounds and Decision Criteria" (1). Based on this assessment, Level 2 inorganic and organic analyses were conducted according to the approach described in Sections 5 and 6 of the referenced text.

This section contains a discussion of the modified Level 1 data available in the Battelle report, and the Level 1 - Level 2 transition details. It also presents the problems anticipated in using these run No. 2 samples for the evaluation of the Level 2 approach developed for Level 1 samples taken specifically according to the IERL-RTP procedures manual. (2)

2.1 BATTELLE MODIFIED LEVEL 1 DATA

The Battelle data provided for evaluation will be referred to throughout this report as modified Level 1. These data were not generated from a standard Level 1 environmental assessment according to the IERL-RTP procedures manual (EPA-600/2-76-160a). Table 2-1 summarizes the Battelle supplied data, indicates the areas more complete than a standard Level 1 and less complete than Level 1, and the impact this modified information has on the data assessment.

In general the full applicability of the Level 1 Data Reduction and Decision Charts prepared for and presented in the referenced Level 2 text cannot be demonstrated by the Battelle data. The significant areas where data are not available or are deficient:

- The on-site volatile organics, C1-C6
- The home-site volatile organics, C6-C12
- Quantitative analysis for arsenic, antimony and mercury
- The Source Assessment Sampling System (SASS) was not used for sampling. Therefore, the modified Level 1 analysis

Table 2-1. Summary of Battelle Level 1 Data with Generalized Comments on Run No. 2 Data from September 22, 1976 Report

ASPECT	MORE COMPLETE THAN LEVEL 1	LESS COMPLETE THAN LEVEL 1	IMPACT ON ASSESSMENT
ON-SITE DATA		• SASS Not Used • C1-C6 Not Conducted	• Most Emitted Organics Not Retained for Analysis • No Data on MEG <C6
ORGANIC ANALYSES	• GC/MS Data for Poly-Nuclear Aromatic Hydrocarbons (POM) • Data Complete for Reduced Organic Species.	• C7-C12 Not Conducted. • Infrared and LRMS Data Not Conducted on LC Samples. • LC Recoveries Not Discussed.	• No Data on MEG <C12, However, GC/MS Data Excellent for POM and Sulfur Species. • LC Data Can be Evaluated on the Basis of Theoretical Compound Types per Fraction Only.
INORGANIC ANALYSES	• Acidic and Basic Gases in Flue Gas by Ion Chromotography.	• Hg, Sb, As Not Conducted by Wet Chemical Techniques. • No Discussion of SSMS Preparation Techniques.	• Excellent Data on Flue Gas. • SSMS Data for Volatiles Low. • Possible Contaminants Unknown.

was conducted on particulate samples only. Efficient retention of emitted organics was not accomplished.

- Infrared (IR) and Low Resolution Mass Spectrometry (LRMS) were not conducted. Therefore, specific MEG categories are triggered for Level 2 analyses based on liquid chromatography (LC) weight criteria only. If IR and LRMS data were available, it might have been possible to eliminate some categories from Level 2 consideration.

Table 2-2 presents total emission data; the summation of the Level 1 data on the sludge (S-2-5), the particulate >27μ (S-2-6), and the particulate <27μ (S-2-7), for the Battelle 6-inch Fluidized Bed Combustor Unit. Any Level 1 reporting point, e.g., LC fraction, which exceeds a Minimum Acute Toxicity Effluent (MATE) guideline or is within the Level 1 uncertainty factor of ±2 or 3 triggers the Level 2 analysis of that particular fraction or sample. Table 2-3 summarizes the MEG categories in LC fractions and inorganic elements in the FBC run No. 2 samples which have been triggered for Level 2 analysis by this transition methodology.

2.2 LEVEL 2 REQUIRED ANALYSIS BASED ON MATE DECISION CRITERIA

Table 2-3 summarizes the MEG categories and elements for which Level 2 analyses are required based on the MATE decision criteria. Level 2 is required where the $\mu g/m^3$ concentration value for the particular FBC sample is within a factor of 3 of the MATE value (the Level 1 sampling and analysis uncertainty factor).

The MEG compound specific Level 2 plan was designed to identify and quantify the compounds present in each sample or sample fraction and the plan has been followed for the FBC samples. Level 2 leachate studies were performed on samples expected to be stored as landfill to assess the FBC samples' MATE ($\mu g/\ell$) water impact. An aqueous inorganic extraction procedure outlined in the Level 2 scheme has been followed. These samples were then analyzed for cation content and assessed as water emission samples.

The Illinois coal sample, S-2-1, and the limestone sample, S-2-2, data could not be reduced and compared to MATE decision criteria; $\mu g/m^3$ does not apply to these samples. However, they were analyzed in the Level 2

Table 2-2. Total Emission Data From 6-inch FBC Unit*

LEVEL 1 - LEVEL 2 DATA REDUCTION TABLES, REV. II.

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE ($\mu g/m^3$) (ppm) $\mu g/l$	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD^1	TEST EXPECTATIONS^2	TEST COST^3	SAMPLE ALIQUOT^4
1. ALIPHATIC HYDROCARBONS A. ALKANES AND CYCLIC ALKANES	Hexanes	3.6×10^{5} (100)	5.4×10^{6}	1.0×10^{5}	1.1×10^{4}	$>2.0 \times 10^{2}$	GAS, FIELD, C6	N.D.						
	Nonanes	1.05×10^{6} (200)	1.57×10^{7}	N	3.2×10^{4}	N	SASS, LAB, C9	N.D.						
	Cyclohexane	1.05×10^{6} (300)	1.58×10^{7}	1.0×10^{3}	3.2×10^{4}	2.0	GAS, FIELD, C6	N.D.						
	Butanes	1.4×10^{6} (600)	2.1×10^{7}	$>1.0 \times 10^{5}$	4.2×10^{4}	$>2.0 \times 10^{2}$	GAS, FIELD, C4	N.D.						
	Octanes	1.45×10^{6} (300)	2.18×10^{7}	N	4.4×10^{4}	N	SASS, LAB, C8	N.D.						
	Heptanes	1.6×10^{6} (400)	2.4×10^{7}	1.0×10^{5}	4.8×10^{4}	2.0×10^{2}	SASS, LAB, C7	N.D.						
	Pentanes	1.8×10^{6} (600)	2.7×10^{7}	1.0×10^{3}	5.4×10^{4}	2.0	GAS, FIELD, C5	N.D.						
	Methane	3.3×10^{6} (5000)	4.91×10^{7}	$>1.0 \times 10^{5}$	9.8×10^{4}	$>2.0 \times 10^{2}$	GAS, FIELD, C1	N.D.						
	Ethane	6.12×10^{6} (5000)	9.18×10^{7}	N	1.8×10^{5}	N	GAS, FIELD, C2	N.D.						
	Propane	9.0×10^{6} (5000)	1.35×10^{8}	$>1.0 \times 10^{5}$	2.8×10^{5}	$>2.0 \times 10^{2}$	GAS, FIELD, C3	N.D.						
	Cyclopetane	N	N	$>1.0 \times 10^{5}$	1.1×10^{4}	$>2.0 \times 10^{2}$	GAS, FIELD, C5	N.D.						
	Alkanes (C>9)	N	N	N	N	N	SASS, LAB, C10-12, LC1	7.6×10^{2}	N					
B. ALKENES, CYCLIC Alkenes and Dienes	Cyclopentadienes	2.0×10^{5} (75)	3.0×10^{6}	N	6.0×10^{3}	N	GAS, FIELD, C5	N.D.						
	Cyclohexene	1.0×10^{6} (300)	1.5×10^{7}	N	3.0×10^{4}	N	GAS, FIELD, C6	N.D.						
	Hexenes	1.02×10^{6} (300)	1.53×10^{7}	N	N	N	GAS, FIELD, C6	N.D.						
	Butadienes	2.2×10^{6} (1000)	3.3×10^{7}	1.0×10^{3}	6.6×10^{4}	2.0	GAS, FIELD, C3	N.D.						
	Ethylene	5.71×10^{6} (5000)	8.57×10^{7}	1.0×10^{4}	1.7×10^{5}	2.0×10	GAS, FIELD, C1	N.D.						
	Propylene	8.59×10^{6} (5000)	1.29×10^{8}	1.0×10^{5}	2.6×10^{5}	2.0×10^{2}	GAS, FIELD, C2	N.D.						
	Butylenes	N	N	N	N	N	GAS, FIELD, C3	N.D.						
	Pentenes	N	N	N	N	N	GAS, FIELD, C5	N.D.						
	Cyclohexadiene	N	N	N	N	N	GAS, FIELD, C5	N.D.						
	Heptenes	N	N	1.0×10^{5}	N	2.0×10^{2}	GAS, FIELD, C6	N.D.						
C. ALKYNES	Propyne	1.65×10^{6} (1000)	2.48×10^{7}	N	5.0×10^{4}	N	GAS, FIELD, C3	N.D.						
	Acetylene	5.31×10^{6} (5000)	7.97×10^{7}	N	1.6×10^{5}	N	GAS, FIELD, C2	N.D.						
	Butyne	N	N	N	N	N	GAS, FIELD, C3	N.D.						
2. HALOGENATED ALIPHATIC HYDROCARBON A. SATURATED ALKYL HALIDES	Hexachlorocyclohexane (Lindone)	5.0×10^{2}	7.50×10^{3}	1.0×10^{2}	1.5×10^{1}	2.0×10^{-1}	SASS, LAB, C11	N.D.						
	Methyl iodide	8.54×10^{2}	1.28×10^{4}	N	2.6×10^{1}	N	GAS, FIELD, C5	N.D.						

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE (µg/m³) (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Tribromomethane	5.0 x 10^3 (0.5)	7.5 x 10^4	N	1.5 x 10^2	N	SASS, LAB, C10	N.D.						
	Hexachloroethane	1.0 x 10^4 (1)	1.5 x 10^5	N	3.0 x 10^2	N	SASS, LAB, C11	N.D.						
	1,1,2-Trichloroethane	4.5 x 10^4 (10)	6.75 x 10^5	1.0 x 10^3	1.4 x 10^3	2.0	GAS, FIELD, C5	N.D.						
	Carbon tetrachloride	5.98 x 10^4	8.97 x 10^5	1.0 x 10^3	1.8 x 10^3	2.0	GAS, FIELD, C5	N.D.						
	Methyl bromide	6.0 x 10^4 (15)	9.0 x 10^5	>1.0 x 10^5	1.8 x 10^3	72.0 x 10^2	GAS, FIELD, C4	N.D.						
	Chloroform	1.2 x 10^5 (25)	6.0 x 10^5	N	1.2 x 10^3	N	GAS, FIELD, C6	N.D.						
	1,2-Dichloroethane	2.0 x 10^5 (50)	3.0 x 10^6	1.0 x 10^4	6.0 x 10^3	2.0 x 10^1	GAS, FIELD, C5	N.D.						
	Methyl chloride	2.1 x 10^5 (100)	3.15 x 10^6	>1.0 x 10^5	6.4 x 10^3	2.0 x 10^2	GAS, FIELD, C3	N.D.						
	Dichloropropanes	3.5 x 10^5 (75)	5.25 x 10^6	1.0 x 10^3	1.1 x 10^4	2.0	GAS, FIELD, C6	N.D.						
	Dichloromethane	7.2 x 10^5 (200)	1.08 x 10^7	4.5 x 10^3			SASS, LAB, C8	N.D.						
	Bromochloromethane	1.1 x 10^6 (200)	1.7 x 10^7	N	3.4 x 10^4	N	GAS, FIELD, C6	N.D.						
	1,2-Dichloro-1,2-difluoroethane	4.95 x 10^6 (1000)	7.43 x 10^7	N	1.5 x 10^5	N	GAS, FIELD, C5	N.D.						
	Dichlorodifluoromethane	4.95 x 10^6 (1000)	7.43 x 10^7	>1.0 x 10^5	1.5 x 10^5	72.0 x 10^2	GAS, FIELD, C3	N.D.						
	Trichlorofluoromethane	5.6 x 10^6	8.4 x 10^6	N	1.7 x 10^5	N	GAS, FIELD, C4	N.D.						
	Bromodichloromethane	N	N	N	N	N	GAS, FIELD, C6	N.D.						
	Dibromodichloromethane	N	N	N	N	N	GAS, FIELD, C8	N.D.						
	Bromobutanes	N	N	N	N	N	SASS, LAB, C7	N.D.						
	1-Chlorooctane	N	N	N	N	N	SASS, LAB, C11	N.D.						
B. UNSATURED ALKYL HALIDES	Hexachlorocyclopentadiene	1.1 x 10^2 (0.01)	1.65 x 10^3	N	3.4	N	SASS, LAB, LC2	7.4x10^2	6.7	YES	1-E	1	1	1
	Chloroethene	2.55 x 10^3 (1)	3.83 x 10^4	>71.0 x 10^5	7.6 x 10^1	2.0 x 10^2	GAS, FIELD, C3	N.D.						
	Hexachlorobutadiene	4.0 x 10^3	6.07 x 10^4	N	1.2 x 10^2	N	SASS, LAB, LC2	7.4x10^2	6.7	YES	1-E	1	1	1
	Dichloropropenes	1.12 x 10^4	1.68 x 10^5	1.0 x 10^3	3.4 x 10^2	2.0	GAS, FIELD, C6	N.D.						
	1,1-Dichloroethene	2.59 x 10^5	3.88 x 10^6	4.5 x 10^3			GAS, FIELD, C5	N.D.						
	Tetrachloroethene	6.7 x 10^5 (100)	1.01 x 10^7	1.0 x 10^3	2.0 x 10^4	2.0	SASS, LAB, C8	N.D.						
	1,2-Dichloroethene	7.0 x 10^5 (200)	1.10 x 10^7	1.0 x 10^4	2.2 x 10^4	2.0 x 10^1	GAS, FIELD, C5	N.D.						
3. ETHERS	2-Ethyl-4-Methyl-1,3-Dioxolanes	2.25 x 10^4	3.38 x 10^5	N	6.8 x 10^2	N	SASS, LAB, C8	N.D.						
	1,3-Dioxane	1.8 x 10^5 (50)	2.7 x 10^6	N	5.4 x 10^3	2.0 x 10^1	SASS, LAB, C7	N.D.						
	1,4-Dioxane	1.8 x 10^5	2.7 x 10^6	1.0 x 10^4	5.4 x 10^3	2.0 x 10^1	SASS, LAB, C7	N.D.						
	Isopropyl ether	1.05 x 10^6 (250)	1.58 x 10^7	1.0 x 10^4	3.2 x 10^4	2.0 x 10^1	SASS, LAB, C7	N.D.						
	2-Methoxybiphenyl	N	N	N	N	N	SASS, LAB, C7	N.D.						

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6, and S-2-7.

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE μg/m³ (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD¹	TEST EXPECTATIONS²	TEST COST³	SAMPLE ALIQUOT⁴
4. HALOGENATED ETHERS	1,1-Dichlorodiethyl ether	3.0×10^4 (5)	4.5×10^5	N	9.0×10^2	N	SASS, LAB, C7	N.D.						
	1,2-Dichloroethyl ether	3.0×10^4 (5)	4.5×10^5	4.5×10^3	N	N	SASS, LAB, C9	N.D.						
	2,2-Dichlorodiethyl ether	3.0×10^4 (5)	4.5×10^5	1.0×10^4	9.0×10^2	2.0×10^1	SASS, LAB, C10	N.D.						
	Chloromethyl methyl ether	3.68×10^4	5.52×10^5	4.5×10^3	1.1×10^3	9.0	GAS, FIELD, C5	N.D.						
	1,1-Dichloromethyl ether	N	N	N	N	N	SASS, LAB, C7	N.D.						
	2-Chloro-1,2 epoxypropane	N	N	N	N	N	SASS, LAB, LC4	4×10^2	N					
	2-Chloroethyl methyl ether	N	N	N	N	N	GAS, FIELD, C6	N.D.						
	1-Chloro-1,2-oxetane	N	N	N	N	N	SASS, LAB, C7	N.D.						
	Chloroethylethyl ether	N	N	N	N	N	SASS, LAB, C7	N.D.						
	1,2-Dichloroethyl ethyl ether	N	N	N	N	N	SASS, LAB, C9	N.D.						
	α-Chlorobutylethyl ether	N	N	N	N	N	SASS, LAB, C10	N.D.						
	bis-(1-Chloroisopropyl) ether	N	N	N	N	N	SASS, LAB, C11	N.D.						
	Bromophenyl phenyl ether	N	N	N	N	N	SASS, LAB, LC4	4×10^2	N					
5. ALCOHOLS A. PRIMARY ALCOHOLS	α-Hydroxytholyene	5.5×10^{-4}	8.3×10^5	1.0×10^4	1.7×10^3	2.0×10^1	SASS, LAB, C12	N.D.						
	Isobutylalcohol	1.5×10^5 (50)	2.3×10^6	1.0×10^4	4.5×10^3	2.0×10^1	SASS, LAB, C7	N.D.						
	Pentanols (Primary)	3.6×10^5 (100)	5.4×10^6	1.0×10^4	1.1×10^4	2.0×10^1	SASS, LAB, C8	N.D.						
	1-Propanol	5.0×10^5	7.5×10^6	1.0×10^4	1.5×10^4	2.0×10^1	GAS, FIELD, C6	N.D.						
	Butanols (Primary) N-Butanol	1.5×10^5 (50)	2.25×10^6	$>1.0 \times 10^5$	4.5×10^3	2.0×10^2	SASS, LAB, C8	N.D.						
	Methanol	2.6×10^5 (200)	3.9×10^6	$>1.0 \times 10^5$	7.8×10^3	2.0×10^2	GAS, FIELD, C6	N.D.						
	Ethanol	1.9×10^6 (1000)	2.85×10^7	$>1.0 \times 10^5$	5.8×10^4	2.0×10^2	GAS, FIELD, C6	N.D.						
B. SECONDARY ALCOHOLS	Phenyl Ethanol	1.8×10^4	2.7×10^5	N	5.4×10^2	N	SASS, LAB, LC6	3.6×10^2	0.02	NO				
	Benzyl	5.54×10^4	8.31×10^5	1.0×10^4			SASS, LAB, LC6	3.6×10^2						
	Borneol	9.0×10^4	1.35×10^6	N	4.8×10^3	N	SASS, LAB, LC6	3.6×10^2						
	2,6-Dimethyl-4-heptanol	1.6×10^5	2.4×10^6	N	4.8×10^3	N	SASS, LAB, C6	N.D.						

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN
   - A. AAS
   - B. XRD
   - C. WET CHEMICAL
   - D. ESCA
   - E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch EBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE μg/m³ (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Pentonols (secondary)	3.6 x 10^5 (100)	5.4 x 10^6	N	1.1 x 10^4	N	SASS, LAB, C8	N.D.						
	2-Butanol	4.8 x 10^5 (150)	6.75 x 10^6	>1.0 x 10^5	1.4 x 10^4	2.0 x 10^2	GAS, FIELD, C6	N.D.						
	2-Propanol	9.8 x 10^5 (400)	1.47 x 10^7	1.0 x 10^4	3.0 x 10^4	2.0 x 10	GAS, FIELD, C6	N.D.						
C. TERTIARY ALCOHOLS	Tertiary Pentanol	4.5 x 10^4	6.75 x 10^5	>1.0 x 10^5	1.4 x 10^3	2.0 x 10^2	GAS, FIELD, C6	N.D.						
	α-Terpineol	1.95 x 10^5	2.89 x 10^6	N	5.8 x 10^3	N	SASS, LAB, LC6	3.6x10^2	0.002	NO				
	Tertiary Butanol	3.0 x 10^5 (100)	4.5 x 10^6	>1.0 x 10^5	9.0 x 10^3	2.0 x 10^2		N.D.						
	Isoborneol	N	N	N	N	N	SASS, LAB, LC6	3.6x10^2	N					
6. GLYCOLS, EPOXIDES A. GLYCOLS	Ethylene glycol	1.0 x 10^4	1.5 x 10^5	1.0 x 10^4	3.0 x 10^2	2.0 x 10^1	SASS, LAB, C11	N.D.						
	Propylene glycol	3.6 x 10^5 (100)	5.4 x 10^6	>1.0 x 10^5	1.1 x 10^4	2.0 x 102	SASS, LAB, C11	N.D.						
B. EPOXIDES	1-Chloro-2,3-epoxypropane	1.63 x 10^4	2.45 x 10^5	1.0 x 10^3	4.8 x 10^2	2.0	SASS, LAB, C8	N.D.						
	2,3-Epoxy-1-propanol	1.5 x 10^4 (50)	2.3 x 10^5	N	5.2 x 10^3	N	SASS, LAB, C10	N.D.						
7. ALDEHYDES, KETONES A. ALDEHYDES	Acrolein	2.5 x 10^2 (0.1)	3.75 x 10^3	<1.0 x 10^2	7.5	2.0 x 10^{-1}	GAS, FIELD, C5	N.D.						
	Formaldehyde	1.6 x 10^3	2.4 x 10^4	1.0 x 10^3	4.8 x 10^1	2.0	GAS, FIELD, C3	N.D.						
	Propionaldehyde	3.6 x 10^4	5.4 x 10^5	1.0 x 10^4	1.1 x 10^3	2.0 x 10	GAS, FIELD, C5	N.D.						
	Benzaldehyde	5.83 x 10^4	8.77 x 10^5	N	1.8 x 10^3	N	SASS, LAB, C10	N.D.						
	Butyraldehyde	1.12 x 10^5	1.68 x 10^6	1.0 x 10^2	3.3 x 10^3	2.0 x 10^{-1}	GAS, FIELD, C6	N.D.						
	Acetaldehyde	1.8 x 10^5 (100)	2.7 x 10^6	N	5.4 x 10^3	N	GAS, FIELD, C4	N.D.						
	3-Methylbutanal	3.86 x 10^5	5.79 x 10^6	1.0 x 10^3	1.2 x 10^4	2.0	GAS, FIELD, C6	N.D.						
B. KETONES	Camphor	1.2 x 10^4 (2)	1.8 x 10^5	N	3.6 x 10^2	N	SASS, LAB, LC4	4.1x10^2	0.034	NO				
	Isophorone	2.5 x 10^4	3.75 x 10^5	N	7.5 x 10^2	N	SASS, LAB, LC4	4.1x10^2		NO				
	Acetophenone	4.05 x 10^4	6.07 x 10^5	N	1.2 x 10^3	N	SASS, LAB, LC4	4.1x10^2		NO				
	Acetone	2.4 x 10^6 (1000)	3.6 x 10^7	>1.0 x 10^5	7.2 x 10^4	>2.0 x 10^2	GAS, FIELD, C5	N.D.						
	Butanone	5.9 x 10^5 (200)	8.85 x 10^6	>1.0 x 10^5	1.8 x 10^4	>2.0 x 10^2	GAS, FIELD, C6	N.D.						
	Tetrachloro-acetone	N	N	N	N	N	SASS, LAB, C11	N.D.						
	Chlorohydroxy Benzophenone	N	N	N	N	N	SASS, LAB, LC4	4.1x10^2	N					
	5,6-Benzo-9-Anthrone	N	N	N	N	N	SASS, LAB, LC4	4.1x10^2	N					
	Dihydro(d)carvone	N	N	N	N	N	SASS, LAB, LC4	4.1x10^2	N					

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE $\mu g/m^3$ (ppm) $\mu g/l$	RATIO $\frac{\text{SAMPLE}}{\text{MATE}}$	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
8. CARBOXYLIC ACIDS A. CARBOXYLIC ACIDS	Maleic	1.0×10^3 (0.25)	1.5×10^4	N	3.0×10^1	N	SASS, LAB, C8	N.D.						
	Phthalic	6.0×10^3 (1:0)	9.0×10^4	N	1.8×10^2	N	SASS, LAB, LC7 & 8	8.2×10^2	0.14	NO				
	Formic	9.0×10^3 (5.0)	1.4×10^5	N	2.7×10^2	N	SASS, LAB, C8	N.D.						
	Acetic	2.5×10^4 (10)	3.8×10^5	1.0×10^3	7.6×10^2	2.0	SASS, LAB, LC7 & 8	8.2×10^2		NO				
	Benzoic	1.4×10^5	2.1×10^6	N	4.2×10^3	N	SASS, LAB, C8, 8 & LC7	8.2×10^2		NO				
	Long Chain	N	N	N	N	N	SASS, LAB, C8, 8 & LC7	8.2×10^2		NO				
B. CARBOXYLIC ACIDS WITH ADDITIONAL FUNCTIONAL GROUPS	3-Hydroxypropanoic Acid Lactone	3.17×10^2	4.76×10^3	1.0×10^4	9.6	2.0×10	SASS, LAB, C10	N.D.						
	β-Propiolactone	3.2×10^2	1.6×10^3	N	3.2	N								
	Hydroxybenzoic Acid	4.01×10^4	6.01×10^5	N	1.2×10^3	N	SASS, LAB, C7	N.D.						
	Hydroxyacetic Acid	8.78×10^4	1.13×10^6	N	2.6×10^3	N	SASS, LAB, LC7	8.2×10^2		NO				
C. AMIDES	6-Hevanelactam	1.0×10^3	1.5×10^4	N	3.0	N	SASS, LAB, C7	N.D.						
	Formamide	3.0×10^4 (20)	4.5×10^5	N	9.0×10^2	N	SASS, LAB, LC7	8.2×10^2	0.03	NO				
	Acetamide	4.5×10^5	6.75×10^6	N	1.4×10^4	N	SASS, LAB, LC7	8.2×10^2		NO				
	6-Aminohexanoic Acid	2.33×10^6	3.5×10^7	N	N	N	SASS, LAB, LC8	8.2×10^2		NO				
D. ESTERS	Phthalates	5.0×10^3	7.5×10^4	1.5	1.5×10^2	3.0×10^{-3}	SASS, LAB, LC6	3.6×10^2	0.07	NO				
	Methyl Methacrylate	4.1×10^5 (100)	6.2×10^6	1.0×10^4	1.2×10^4	2.0×10	SASS, LAB, C7	N.D.						
	Adipates	1.89×10^4	2.83×10^5	N	5.6×10^2		SASS, LAB, C8, 9 & 10	N.D.						
	Methyl Benzoate	1.5×10^5	2.25×10^6	N	4.6×10^3	N	SASS, LAB, C10	N.D.						
	Phenyl Benzoate	N	N	N	N	N	SASS, LAB, LC6	3.6×10^2	N					
	Di-2-ethylhexyl phthalate	N	N	N	N	N	SASS, LAB, LC6	3.6×10^2						
	Long chain esters	N	N	N	N	N	SASS, LAB, LC6	3.6×10^2						
9. NITRILES	1-Cyanoethane	1.76×10^3	2.64×10^4	N	5.4×10	N	GAS, FIELD, C6	N.D.						
	Tetramethyl-succinonitrile	3.0×10^3 (0.5)	4.5×10^4	N	9.0×10	N	SASS, LAB, LC4	4.1×10^2	0.13	NO				
	Butyronitrile	2.25×10^4	3.37×10^5	N	6.8×10^2	N	SASS, LAB, LC4	4.1×10^2		NO				
	Benzonitrile	3.24×10^4	4.86×10^5	N	1.4×10^3	2.0	SASS, LAB, C11	N.D.						
	Acrylonitrile	4.5×10^4 (20)	6.8×10^5	1.0×10^3	1.4×10^3		SASS, LAB, C11	N.D.						
	Acetonitrile	7.0×10^4 (40)	1.05×10^6	1.0×10^5	2.1×10^3	2.0×10^2	GAS, FIELD, C6	N.D.						
	Naphthonitriles	N	N	N	N	N	SASS, LAB, LC4	[illegible]$.1 \times 10^2$	N					

*Summation of S-2-6, S-2-6 and S-2-7

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOP-MENTAL
   3. UNKNOWN
   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE µg/m^3 (ppm) µg/l	RATIO $\frac{\text{SAMPLE}}{\text{MATE}}$	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
10. AMINES	1-Aminonaphtalene	5.5×10^2	8.5×10^3	1.0×10^2			SASS, LAB, LC7	8.2×10^2	1.5	YES	1-E	1	1	1
A. PRIMARY	Methylamine	1.81×10^3	2.72×10^4	N	3.6×10	2.0	SASS, LAB, LC6	3.6×10^2	0.19	NO				
	4-Aminibiphenyl	1.2×10^3 (10)	1.8×10^4	1.0×10^3			GAS, FIELD, C6	N.D.						
	Ethanolamine	6.0×10^3 (3)	9.0×10^4	1.0×10^4	1.8×10^2	2.0×10	SASS, LAB, C10	N.D.						
	Butylamines	1.5×10^4 (5)	2.25×10^5	$>1.0 \times 10^5$	4.5×10^2	2.0×10^2	GAS, FIELD, C6	N.D.						
	Ethylamine	1.8×10^4 (10)	2.7×10^5	1.0×10^3	5.4×10^2	2.0	GAS, FIELD, C4	N.D.						
	1,2-Diaminoethane	2.5×10^4 (10)	3.75×10^5	1.0×10^3	7.6×10^2	2.0	SASS, LAB, C8	N.D.						
	Cyclohexylamine	4.0×10^4 (10)	6.0×10^5	1.0×10^4	1.2×10^3	2.0×10	SASS, LAB, C8	N.D.						
	Propanolamine	1.27×10^5	1.9×10^6	N	3.8×10^3	N	SASS, LAB, C9	N.D.						
	3-Aminopropene	N	N	N	N	N	GAS, FIELD, C5	N.D.						
B. SECONDARY	Ethyleneimine	3.33×10^2	5.0×10^3	N	1.0×10	N	GAS, FIELD, C3?	N.D.						
	Dimethylamine	1.8×10^4 (10)	2.7×10^5	1.0×10^3	5.4×10^2	2.0	GAS, FIELD, C3?	N.D.						
	Morpholine	7.0×10^4 (20)	1.05×10^6	1.0×10^4	2.1×10^3	2.0×10	SASS, LAB, LC6?	3.6×10^2	0.005	NO				
	Diethylamine	7.5×10^4 (25)	1.13×10^6	1.0×10^3	2.2×10^3	2.0	GAS, FIELD, C3?	N.D.						
	Ethylmethylamine	N	N	N	N	N	GAS, FIELD, C4?	N.D.						
C. TERTIARY AMINES	Aminotoluenes	1.1×10^2	1.7×10^3	N	3.0	N	SASS, LAB, C11	N.D.						
	2-Aminonaphthalene	1.7×10^2	2.5×10^3	1.0×10^2	5.0	2.0×10^{-1}	SASS, LAB, LC6	3.6×10^2	2.1	YES	1-E	1	1	1
	4,4^1-Methylene-bis-(2-chloro-ani.ine	2.18×10^2	3.27×10^3	N	6.0	N	SASS, LAB, LC7	8.2×10^2	3.8	YES	1-E	1	1	1
	Anisidines	5.0×10^2 (0.1)	7.5×10^3	N	1.5×10	N	SASS, LAB, LC6	3.6×10^2	0.7	YES	1-E	1	1	1
	4-Aminibiphenyl	1.3×10^3	2.0×10^4	N	4.0	N	SASS, LAB, LC6	3.6×10^2						
	1,4-Diaminobenzene	4.5×10^3	6.75×10^4	N	1.4×10^3	N	SASS, LAB, LC6	3.6×10^2						
	3,3'-Dichloro-benzidine	6.6×10^3	9.9×10^4	N	2.0×10^2	N	SASS, LAB, LC7	8.2×10^2						
	Benzidine	1.4×10^4	2.1×10^5	1.0×10^2	4.2×10^2	2.0×10^{-1}	SASS, LAB, LC7	8.2×10^2						
	Aniline	1.9×10^4 (5)	2.85×10^5	1.0×10^3	6.0×10^2	2.0	SASS, LAB, C11	N.D.						
	Dimethylaniline	2.5×10^4 (5)	3.75×10^5	N	7.5×10^2	N	SASS, LAB, C11	N.D.						
	N,N-Dimethyl-aniline	2.5×10^4 (5)	3.83×10^5	N	7.5×10^2	N	SASS, LAB, LC6	3.6×10^2						
11. AZO COMPOUNDS	N,N'-Dimethyl-hydrazine	3.17×10	4.76×10^2	N	1.0	N	GAS, FIELD, C6	N.D.						
	Monoethyl-hydrazine	3.5×10^2 (0.2)	5.25×10^3	N	1.1×10	N	GAS, FIELD, C6	N.D.						
	Diazomethane	4.0×10^2 (0.2)	6.0×10^3	N	1.2×10	N	GAS, FIELD, C3	N.D.						
	N,N-Dimethyl-hydrazine	1.0×10^3 (0.5)	1.5×10^4	N	3.0×10	N	SASS, LAB, C8	N.D.						
	Hydrazobenzene	1.35×10^4	2.02×10^5	N			GAS, FIELD, C6	N.D.						
	Diphenylhydrazines	1.4×10^4	2.0×10^5	N	4.0×10^2	N	SASS, LAB, LC7	8.2×10^2	0.001	NO				
	Hydrazine	N	N	N			SASS, LAB, C8	N.D.						

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE $\mu g/m^3$ (ppm) μg/l	RATIO SAMPLE / MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
12. NITROSAMIES	N-Nitroso-Dimethylamine	1.2	1.8×10	N	3.6×10^{-2}	N	SASS, LAB, C9	N.D.						
	N-Nitroso-Diethylamine	1.21×10^2	1.82×10^3	N	3.6	N	SASS, LAB, C10	N.D.						
	N-Methyl-N-Nitroso-Amiline	1.29×10^3	1.94×10^4	N	3.8×10	N	SASS, LAB, LC5	2.4×10^2	0.18	NO				
	N-Nitrosp-Di-propylaime	2.41×10^3	3.62×10^4	N	7.2×10	N	SASS, LAB, C12 & LC5	2.4×10^2						
	N-Nitroso-Di-phenylamine	7.4×10^4	1.1×10^6	N	2.2×10^3	N	SASS, LAB, LC5	2.4×10^2						
	N-Nitroso-Diiso-propylamine	3.83×10^4	5.75×10^5	N	1.2×10^3	N	SASS, LAB, C11	N.D.						
	N-Nitroso-Di-pentylamine	N	N	N	N	N	SASS, LAB, LC5	2.4×10^2						
13. MERCAPTANS, SULFIDES A. MERCAPTANS	Perchloromethyl Mercaptan	8.0×10^2 (0.1)	1.2×10^4	N	2.4×10	N	SASS, LAB, LC6	3.6×10^2	0.45	YES	1-E	1	1	1
	Methyl Mercaptan	1.0×10^3 (0.5)	1.5×10^4	N	3.0×10	N	GAS, FIELD, SGC	N.D.						
	Ethyl Mercaptan	1.0×10^3 (0.5)	1.5×10^4	N	3.0×10	N	GAS, FIELD, SGC	N.D.						
	Butyl Mercaptans	1.5×10^3 (0.5)	2.25×10^4	N	4.5×10	N	GAS, FIELD, SGC	N.D.						
	Benzenthiol	2.07×10^3	3.10×10^4	N	6.2×10	N	SASS, LAB, LC6	3.6×10^2						
	Propyl Mercaptans	8.06×10^4	1.21×10^6	N	2.4×10^3	N	GAS, FIELD, SGC	N.D.						
	1-Anthranthiol	N	N	N	N	N	SASS, LAB, LC6	3.6×10^2						
B. SULFIDES DISULFIDES	Dimethyl Sulfide	2.41×10^4	3.61×10^5	N	7.2×10^2	N	GAS, FIELD, SGC	N.D.						
	Phenyl Sulfide	9.63×10^4	1.44×10^6	N	2.9	N	SASS, LAB, C9 & LC5	2.4×10^2						
	Diethyl Sulfide	N	N	N	N	N	GAS, FIELD, SGC	N.D.						
	Methyl Disulfide	N	N	N	N	N	SASS, LAB, C8	N.D.						
14. SULFONIC ACIDS, SULFOXIDES A. SULFONIC ACIDS	Benzensulfonic Acid	4.01×10^4	6.01×10^5	N	1.2×10^3	N	SASS, LAB, LC8	7.6×10	0.002	NO				
	9,10-Anthraquinone-Disulfonic Acid	N	N	N	N	N	SASS, LAB, LC8	7.6×10						
B. SULFOXIDES	Dimethyl Sulfoxide	8.14×10^2	1.22×10^3	N	2.4	N	SASS, LAB, C11	N.D.						

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE µg/m^3 (ppm) µg/l	RATIO SAMPLE / MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD^1	TEST EXPECTATIONS^2	TEST COST^3	SAMPLE ALIQUOT^4
15. BENZENE, SUBSTITUTED BENZENE	Biphenyl	1.0×10^3 (0.2)	1.5×10^4	N	3.0×10	N	SASS, LAB, LC2	7.4×10^2	0.73	YES	1-E	1	1	1
	Benzene	3.0×10^3 (10)	4.5×10^4	1.0×10^3	9.0×10	2.0	GAS, FIELD, C6	N.D.						
	Terphenyls	9.0×10^3 (1)	1.35×10^5	N	2.8×10^2	N	SASS, LAB, LC3	5.1×10^3	0.06	NO				
	Indene	4.5×10^4 (10)	6.8×10^5	1.0×10^3	1.4	N	SASS, LAB, LC3	5.1×10^3						
	Isopropyl Benzene	6.3×10^4	9.45×10^5	4.5×10^2	1.9×10^3	2.0	SASS, LAB, C9	N.D.						
	Trimethyl Benzenes	1.2×10^5 (25)	1.8×10^6	N	3.6×10^3	N	SASS, LAB, C10	N.D.						
	Dihydronaphthalenes	1.27×10^5	1.91×10^6	1.0×10^3	4.0×10^3	2.0	SASS, LAB, LC2	7.4×10^2						
	Tetrahydronaphthalenes	1.29×10^5	1.94×10^6	1.0×10^3	4.0×10^3	2.0	SASS, LAB, C12, LC2	7.4×10^2						
	Propyl Benzene	2.17×10^5	3.25×10^6	1.0×10^3	6.6×10^3	2.0	SASS, LAB, C9	N.D.						
	Dialkyl Benzene	2.25×10^5	3.38×10^6	1.0×10^3	6.8×10^3	2.0	SASS, LAB, C10, 11, 12	N.D.						
	Butyl Benzene	2.25×10^5	3.38×10^6	N	6.8×10^3	N	SASS, LAB, C11	N.D.						
	Indane	2.3×10^5	3.4×10^6	N	6.8×10^3	N	SASS, LAB, LC2	7.4×10^2						
	Toluene	3.75×10^5 (100)	5.63×10^6	1.0×10^3	1.1×10^4	2.0	SASS, LAB, C8	N.D.						
	Styrene	4.2×10^5 (100)	6.3×10^6	1.0×10^3	1.3×10^4	2.0	SASS, LAB, C9	N.D.						
	Ethyl Benzene	4.35×10^5 (100)	6.53×10^6	1.0×10^3	1.3×10^4	2.0	SASS, LAB, C8	N.D.						
	Xylenes	4.35×10^5 (100)	6.53×10^6	1.0×10^3	1.3×10^4	2.0	SASS, LAB, C9	N.D.						
	4,4^1-Diphenylbiphenyl	N	N	N	N	N	SASS, LAB, LC2 & 3	1.3×10^2	N					
	Tetramethyl Benzenes	N	N	1.0×10^4	N	2.0×10	SASS, LAB, C11	N.D.						
16. HALOGENATED AROMATIC HYDROCARBONS A. RING SUBSTITUED AROMATICS	Polychlorinated biphenyls	5.0×10^2	7.5×10^3	5.0×10^{-3}			SASS, LAB, LC2 & 3	1.3×10^3	2.6	YES	1-E	1	1	1
	Polychlorinated benzenes	3.4×10^4	5.1×10^5	1.0×10^2	1.0×10^3	2.0×10^{-1}	SASS, LAB, LC2 & 3	1.3×10^3						
	Chloronaphthalenes	6.93×10^4	1.04×10^6	N	1.5×10	1.0×10^{-5}	SASS, LAB, LC2 & 3	1.3×10^3						
	2-Chlorotoluene	2.5×10^5 (50)	3.75×10^6	N	7.5×10^3	N	SASS, LAB, C9	N.D.						
	1,2-Dichlorobenzene	3.0×10^5 (50)	4.5×10^6	1.0×10^2	9.0×10^3	2.0×10^{-1}	SASS, LAB, C10	N.D.						
	Chlorobenzene	3.5×10^5 (75)	5.25×10^6	1.0×10^2	1.1×10^4	2.0×10^{-1}	SASS, LAB, C8	N.D.						
	1,4-Dichlorobenzene	4.75×10^5 (75)	6.8×10^6	1.0×10^2	1.4×10^4	2.0×10^{-1}	SASS, LAB, C10	N.D.						

TABLE KEY:

1. TEST METHOD:
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7.

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE µg/m^3 (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
B. AROMATICS WITH HALOGENERATED ALKYL SIDE CHAINS	Bromo and Dibromobenzenes	N	N	N	N	N	SASS, LAB, C9, 12, & LC2	7.4x10^2	N					
	Bromochlorobenzenes	N	N	N	N	N	SASS, LAB, C12 & LC2	7.4x10^2	N					
	1,3-Dichlorobenzene	N	N	N	N	N	SASS, LAB, C10	N.D.						
	α-Chlorotoluene	5.54 x 10^4	8.31 x 10^5	1.0 x 10^2			SASS, LAB, C11	N.D.						
	Bis-(chloromethyl) Benzene	N	N	N	N	N	SASS, LAB, LC2	7.4x10^2						
17. AROMATIC NITRO COMPOUNDS	4-Nitrobiphenyl	1.3 x 10^3	2.0 x 10^4	N	4.0 x 10	N	SASS, LAB, LC4	7.4x10^2	0.32	NO				
	Dinitrotoluenes	1.50 x 10^3	2.25 x 10^4	1.0 x 10^3	4.5 x 10	2.0	SASS, LAB, LC5	2.4x10^2						
	Methoxynitrobenzene	4.5 x 10^3	6.75 x 10^4	N	1.4 x 10^2	N	SASS, LAB, LC5	2.4x10^2						
	Nitrobenzene	5.0 x 10^3 (1.0)	7.5 x 10^4	1.0 x 10^3	1.5 x 10^2	2.0	SASS, LAB, C12 & LC4	4.1x10^2						
	1-Chloro-2-Nitrobenzene	1.3 x 10^4	1.95 x 10^5	1.0 x 10^4	4.0 x 10^2	2.0 x 10	SASS, LAB, LC4	4.1x10^2						
	1-Chloro-4-Nitrobenzene	1.89 x 10^4	2.84 x 105	N	5.8 x 10^2	N	SASS, LAB, LC4	4.1x10^2						
	Nitrotoluenes	3.0 x 10^4 (5)	4.5 x 10^5	1.0 x 10^3	9.0 x 10^2	2.0	SASS, LAB, LC5	4.1x10^2						
18. PHENOLS A. MONOHYDRICS	2,2'-Dihydroxydiphenyls	6.75 x 10^3	5.0	5.0 x 10^2	1.0 x 10^{-2}	1.0	SASS, LAB, LC6	3.6x10^2	0.05	NO				
	Polyalkyl Phenols	1.49 x 10^4	5.0	5.0 x 10^2	1.0 x 10^{-2}	1.0	SASS, LAB, LC6	3.6x10^2						
	Phenol	1.9 x 10^4 (5)	5.0	5.0 x 10^2	1.0 x 10^{-2}	1.0	SASS, LAB, C11	N.D.						
	Cresols	2.2 x 10^4 (5)	5.0	5.0 x 10^2	1.0 x 10^{-2}	1.0	SASS, LAB, C12 & LC6	3.6x10^2						
	Phenyl Phenols	2.3 x 10^4	5.0	5.0 x 10^2	1.0 x 10^{-2}	1.0	SASS, LAB, LC6	3.6x10^2						
	Alkyl Cresols	2.39 x 10^4	5.0	5.0 x 10^2	1.0 x 10^{-2}	1.0	SASS, LAB, C12 & LC6	3.6x10^2						
	2-Methoxy Phenol	3.26 x 10^4	5.0	5.0 x 10^2	1.0 x 10^{-2}	1.0	SASS, LAB, LC6	3.6x10^2						
	Xylenols	1.3 x 10^4	5.0	5.0 x 10^2	1.0 x 10^{-2}	1.0	SASS, LAB, LC6	3.6x10^2						
	Ethylphenols	N	5.0	5.0 x 10^2	1.0 x 10^{-2}	1.0	SASS, LAB, LC6	3.6x10^2						

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

A. AAS
B. XRD
C. WET CHEMICAL
D. ESCA
E. GC/MS

2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN

4. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH

4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7.

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE $\mu g/m^3$ (ppm) $\mu g/l$	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
B. DIHYDRICS, POLYHYDRICS	1,4-Dihydroxybenzene	2.0×10^3	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC6	3.6×10^2	0.18	NO				
	Catehol	2.0×10^4 (5)	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC6	3.6×10^2						
	1,2,3-Trihydroxybenzenes	3.55×10^4	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC6	3.6×10^2						
	1,3-Dihydroxybenzene	4.5×10^4 (10)	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, C10	N.D.						
C. FUSED RING HYDROXY COMPOUNDS	1-Naphthol	1.17×10^5	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC6	3.6×10^2						
	2-Naphthol	1.09×10^5	5.0	5.0×10^2	$1.C \times 10^{-2}$	1.0	SASS, LAB, LC6	3.6×10^2						
	Indanols	1.46×10^5	5.0	5.0×10^2	$1.C \times 10^{-2}$	1.0	SASS, LAB, LC6	3.6×10^2						
	Phenanthrols	N	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC6	3.6×10^2						
	Acenaphthenols	N	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC6	3.6×10^2						
	2-Hydroxyfluorene	N	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC6	3.6×10^2						
	2-Hydroxydibenzofuran	N	5.0	5.0×10^2	$1.C \times 10^{-2}$	1.0	SASS, LAB, LC6	3.6×10^2						
19. HALOPHENOLS	Pentachlorophenol	5.0×10^2	5.0	5.0×10^2	$1.C \times 10^{-2}$	1.0	SASS, LAB, LC7	8.2×10^2	1.6	YES	1-E	1	1	1
	Chlorinated Cresols	2.25×10^4	5.0	5.0×10^2	$1.C \times 10^{-2}$	1.0	SASS, LAB, LC6	3.6×10^2						
	2,4-Dichlorophenol	7.0×10^3	5.0	5.0×10^2			SASS, LAB, C12	N.D.						
	2-Chlorophenol	3.02×10^4	5.0	5.0×10^2	$1.C \times 10^{-2}$	1.0	SASS, LAB, C10	N.D.						
20. NITROPHENOLS	Trinitrophenol	1.0×10^2 (0.011)	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC7	8.2×10^2	8.2	YES	1-E	1	1	1
	Dinitro-o-cresol	2.0×10^2 (0.025)	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC7	8.2×10^2						
	Dinitro-p-cresol	6.8×10^2	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC7	8.2×10^2						
	Dinitrophenols	1.35×10^3	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC7	8.2×10^2						
	4-Nitrophenol	1.58×10^4	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC7	8.2×10^2						
	3-Nitrophenol	2.01×10^4	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, C11 & LC7	8.2×10^2						
	2-Amino-4,6-Nitrophenol	4.64×10^4	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, LC7	8.2×10^2						
	2-Nitrophenol	5.8×10^4	5.0	5.0×10^2	1.0×10^{-2}	1.0	SASS, LAB, C12 & LC7	8.2×10^2						
21. FUSED AROMATIC HYDROCARBONS	Benzo(a)pyrene	2.11×10^{-2}	3.17×10^{-1}	N	6.0×10^{-2}	N	SASS, LAB, LC3	5.1×10^2	2.4×10^4	YES	1-E	1	1	1
	Dibenzo(a,h) anthracene	9.27×10^{-2}	1.39	N	3.0×10^{-3}	N	SASS, LAB, LC3	5.1×10^2						
	7,12-Dimethylbenz-(a)-anthracene	2.6×10^{-1}	3.91	N	8.0×10^{-3}	N	SASS, LAB, LC3	5.1×10^2						
	Dibenzo(a,i)pyrene	4.3×10	6.5×10^2	N	1.3	N	SASS, LAB, LC3	5.1×10^2						

*Summation of S-2-5, S-2-6, and S-2-7.

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD:
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE μg/m³ (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	9,10-Dimethyl-1,12-benzanthracene	2.96×10	4.44×10^2	N			SASS, LAB, LC3	5.1×10^2						
	Benz(a)anthracene	4.45×10	6.72×10^2	N	1.3	N	SASS, LAB, LC3	5.1×10^2						
	Dibenzo(b,def) Chrysene	3.32×10^2	4.98×10^3	N	N	N	SASS, LAB, LC3	5.1×10^2						
	Benzo(g,h,i) perylene	5.43×10^2	8.15×10^3	N	N	N	SASS, LAB, LC3	5.1×10^2						
	Dibenzo(a,l)pyrene	1.08×10^3	1.62×10^3	N	3.2×10	N	SASS, LAB, LC3	5.1×10^2						
	Phenanthrene	1.59×10^3	2.39×10^4	N	4.8×10	N	SASS, LAB, LC3	5.1×10^2						
	Methylchrysenes	1.79×10^3	2.69×10^4	N	5.4×10	N	SASS, LAB, LC3	5.1×10^2						
	Chrysene	2.2×10^3	3.3×10^4	N	6.6×10	N	SASS, LAB, LC3	5.1×10^2						
	Picene	2.5×10^3	3.75×10^4	N	7.5×10	N	SASS, LAB, LC3	5.1×10^2						
	Benzo(e)pyrene	3.04×10^3	4.56×10^4	N	9.1×10	N	SASS, LAB, LC3	5.1×10^2						
	Dibenzo(a,h)pyrene	3.68×10^3	5.52×10^4	N	1.1×10^2	N	SASS, LAB, LC3	5.1×10^2						
	Dibenz(a,c) anthracene	9.9×10^3	1.5×10^5	N	3.0×10^2	N	SASS, LAB, LC3	5.1×10^2						
	1,2:3,4-Dibenzo-anthracene	1.0×10^4	1.5×10^5	N			SASS, LAB, LC3	5.1×10^2						
	Benzo(g)chrysene	1.63×10^4	2.45×10^5	N	4.8×10^2	N	SASS, LAB, LC3	5.1×10^2						
	Benzo(c)phen-anthrene	2.69×10^4	4.04×10^5	N	8.2×10^2	N	SASS, LAB, LC3	5.1×10^2						
	Methylphen-anthrenes	3.04×10^4	4.56×10^5	N	9.1×10^2	N	SASS, LAB, LC3	5.1×10^2						
	Naphthalene	5.0×10^4	7.5×10^5	1.0×10^2	1.5×10^3	2.0 x 10-1	SASS, LAB, C11 & LC2	1.3×10^3						
	Anthracene;Methyl Anthracene	5.6×10^4	8.4×10^5	N	1.7×10^3	N	SASS, LAB, LC3	5.1×10^2						
	Monoalkyl Naphthalenes	2.25×10^5	3.38×10^6	N	6.8×10^3	N	SASS, LAB, LC2	1.3×10^3						
	Dimethyl Naphthalenes	2.25×10^5	3.38×10^6	N	6.8×10^3	N	SASS, LAB, LC2	1.3×10^3						
	Pyrene	2.33×10^5	3.5×10^6	N	6.9×10^3	N	SASS, LAB, LC3	5.1×10^2						
	Phenyl Naphthalenes	N	N	N	N	N	SASS, LAB, LC3	5.1×10^2						
	Acenaphthene; Acenaphthylene	N	N	N	N	N	SASS, LAB, LC3	5.1×10^2						
	2,7-Dimethyl-anthracene	N	N	N	N	N	SASS, LAB, LC3	5.1×10^2						
	Naphthacene	N	N	N	N	N	SASS, LAB, LC3	5.1×10^2						
	Triphenylene	N	N	N	N	N	SASS, LAB, LC3	5.1×10^2						

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOP-MENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASON-ABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7.

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/1 HEALTH	MATE WATER μg/1 ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE μg/m³ (ppm) g/1	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD¹	TEST EXPEC-TATIONS²	TEST COST³	SAMPLE ALIQUOT⁴
	1-Methyl Pyrene	N	N	N	N	N	SASS, LAB, LC3	5.1 x 10^2						
	Dimethyl Pyrenes	N	N	N	N	N	SASS, LAB, LC3	5.1 x 10^2						
	1,2 Benzoaphthacene	N	N	N	N	N	SASS, LAB, LC3	5.1 x 10^2						
	Perylene	N	N	N	N	N	SASS, LAB, LC3	5.1 x 10^2						
	Coronene	N	N	N	N	N	SASS, LAB, LC3	5.1 x 10^2						
22. FUSED NON-ALTERNATE POLYCYCLIC HYDROCARBONS	3-Methyl-Cholanthrene	3.75	5.63 x 10	N	1.1 x 10^{-1}	N	SASS, LAB, LC3	5.1 x 10^2	1.4 x 10^2	YES	1-E	1	1	1
	Benzo(b) fluoranthene	8.97 x 10^2	1.35 x 10^4	N	2.8 x 10	N	SASS, LAB, LC3	5.1 x 10^2						
	Benzo(k) fluoranthene	1.63 x 10^3	2.45 x 10^4	N	4.9 x 10	N	SASS, LAB, LC3	5.1 x 10^2						
	Indeno(1,2,3,c,d) pyrene	1.63 x 10^3	2.45 x 10^4	N	4.8 x 10	N	SASS, LAB, LC3	5.1 x 10^2						
	Benzo(j) fluoranthene	6.48 x 10^3	9.72 x 10^4	N	2.0 x 10^2	N	SASS, LAB, LC3	5.1 x 10^2						
	1,2:5,6-Dibenzofluorene	1.32 x 10^4	1.98 x 10^5	N	4.0 x 10^2	N	SASS, LAB, LC3	5.1 x 10^2						
	Dicyclopentadiene	1.59 x 10^4	2.39 x 10^5	1.0 x 10^2	4.8 x 10^2	2.0 x 10^{-1}	SASS, LAB, C10	N.D.						
	Indane, Indene	4.5 x 10^4 (10)	6.75 x 10^5	N	N	N	SASS, LAB, C11	N.D.						
	Fluoranthene, (Tetrahydro-fluoroanthene)	9.0 x 10^4	1.35 x 10^5	N	2.8 x 10^3	N	SASS, LAB, LC3	5.1 x 10^2						
	Fluorene	N	N	N	N	N	SASS, LAB, LC2	1.3 x 10^3	N					
	Cyclopentanonaphthalene	N	N	N	N	N	SASS, LAB, LC2	1.3 x 10^3						
	2,3-Benzofluorene	N	N	N	N	N	SASS, LAB, LC3	5.1 x 10^2						
	1,2-Benzofluorene	N	N	N	N	N	SASS, LAB, LC3	5.1 x 10^2						
	Cyclopenta(def)-phenanthrene	N	N	N	N	N	SASS, LAB, LC3	5.1 x 10^2						
	Truxene(Tribenzylene Benzene)	N	N	N	N	N	SASS, LAB, LC3	5.1 x 10^2						

*Summation of S-2-5, S-2-6, and S-2-7.

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD:
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAX
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE µg/m³ (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
23. HETEROCYCLIC NITROGEN														
A. PYRIDINE & SUBSTITUTED PYRIDINES	Pyridine	1.5 x 10⁴ (5)	2.25 x 10⁵	1.0 x 10⁴	4.5 x 10²	2.0 x 10	SASS, LAB, C8	N.D.						
	Di & polysubstituted pyridines	2.7 x 10⁴	4.05 x 10⁵	N	8.2 x 10²	N	SASS, LAB, C10	N.D.						
	Picolines	3.56 x 10⁴	5.34 x 10⁵	N	1.1 x 10³	N	SASS, LAB, C6	N.D.						
	Chloropyridine	4.82 x 10³	7.23 x 10⁴	N	1.4 x 10²	N	SASS, LAB, C9 & C10	N.D.						
	Collidines	5.9 x 10⁴	1.0 x 10⁶	N	2.1 x 10³	N	SASS, LAB, C8 & LC3	5.1x10²	0.009	NO				
	Monosubstituted Alkyl Pyridines	N	N	N	N	N	SASS, LAB, LC3	5.1x10²						
B. FUSED 6-MEMBERED RING	Dibenz(a,h) acridine	2.24 x 10²	3.36 x 10³	N	6.7	N	SASS, LAB, LC6	3.6x10²	1.6	YES	1-E	1	1	1
	Dibenz(a,j) acridine	2.47 x 10²	3.71 x 10³	N	7.4	N	SASS, LAB, LC6	3.6x10²						
	Benz(c)acridine	1.1 x 10⁴	1.6 x 10⁵	N	3.2 x 10²	N	SASS, LAB, LC6	3.6x10²						
	Quinoline; Isoquinoline	1.58 x 10⁴	2.37 x 10⁵	N	4.7 x 10²	N	SASS, LAB, LC6	3.6x10²						
	Dibenz(c,h) acridine	2.33 x 10⁴	3.5 x 10⁵	N	6.9 x 10²	N	SASS, LAB, LC6	3.6x10²						
	Methylquinolines	5.54 x 10⁴	8.31 x 10⁵	N	1.7 x 10³	N	SASS, LAB, LC6	3.6x10²						
	Acridine	9.0 x 10⁴	1.4 x 10⁶	N	2.7 x 10³	N	SASS, LAB, LC6	3.6x10²						
	Dimethylquinolines	N	N	N	N	N	SASS, LAB, LC6	3.6x10²						
	Dihydroacridine	N	N	N	N	N	SASS, LAB, LC6	3.6x10²						
	Benzo(c)quinolin	N	N	N	N	N	SASS, LAB, LC6	3.6x10²						
	Benzo(f)quinoline	N	N	N	N	N	SASS, LAB, LC6	3.6x10²						
	Benzo(h)quinoline	N	N	N	N	N	SASS, LAB, LC6	3.6x10²						
	Benzo(a)acridine	N	N	N	N	N	SASS, LAB, LC6	3.6x10²						
	Dibenz H-Indeno (1,2-b)quinoline	N	N	N	N	N	SASS, LAB, LC6	3.6x10²						
	Indeno (1,2,3,i,j) isoquinoline	N	N	N	N	N	SASS, LAB, LC6	3.6x10²						
C. PYRROLE AND RING DERIVATIVES	Dibenzo(c,d) carbazole	1.05 x 10³	1.58 x 10³	N	3.0	N	SASS, LAB, LC6	3.6x10²						
	Pyrrole	2.75 x 10³	4.13 x 10⁴	N	8.1 x 10	N	SASS, LAB, LC6	3.6x10²						
	Dibenzo(a,g) carbazole	6.03 x 10³	9.05 x 10⁴	N	1.8 x 10²	N	SASS, LAB, LC6	3.6x10²						
	Indole	1.1 x 10⁴	1.7 x 10⁵	N	3.3 x 10²	N	SASS, LAB, LC6	3.6x10²						

TABLE KEY:

1. TEST METHOD:
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summationof S-2-5, S-2-6, and S-2-7.

N.D. Not Detected
N N Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	WHERE FOUND IN LEVEL I	SAMPLE µg/m³ (ppm) µg/l	RATIO SAMPLE / MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
D. NITROGEN HETEROCYCLES containing ADDN'L HETEROATOMS	Dibenzo(a,i) carbazole	1.15×10^4	1.73×10^5	N	3.6×10^2	N	SASS, LAB, LC6	3.6×10^2						
	Benzo(a) carbazole	1.89×10^4	2.84×10^5	N	5.6×10^2	N	SASS, LAB, LC6	3.6×10^2						
	Carbazole	2.25×10^4	3.38×10^5	N	6.8×10^2	N	SASS, LAB, LC6	3.6×10^2						
	Methylindoles	4.5×10^4	6.75×10^5	N	1.4 x 103	N	SASS, LAB, LC6	3.6×10^2						
	Benzothiazole	4.28×10^3	6.42×10^4	N	6.4×10^4	N	SASS, LAB, LC6	3.6×10^2						
	Methyl Benzthiazoles	4.73×10^3	7.10×10^4	N	1.4×10^2	N	SASS, LAB, LC6	3.6×10^2						
24. HETEROCYCLIC NITROGEN	Tetrahydrofuran	5.9×10^5 (200)	8.85×10^6	N	1.8×10^4	N	SASS, LAB, LC5	2.4×10^2		NO				
	Furan	N	N	N	N	N	GAS, FIELD, C5	N.D.						
	Benzofuran	N	N	N	N	N	SASS, LAB, C10	N.D.						
	Dibenzofuran	N	N	N	N	N	SASS, LAB, LC5	2.4×10^2						
	Methyldibenzo-furanes	N	N	N	N	N	SASS, LAB, LC5	2.4×10^2						
	Naphthofurans	N	N	N	N	N	SASS, LAB, LC5	2.4×10^2						
	Benzo(b)naphto (2,3-d)furan	N	N	N	N	N	SASS, LAB, LC5	2.4×10^2						
	Phenoanthro(9, 10-b)furan	N	N	N	N	N	SASS, LAB, LC5	2.4×10^2						
	1-9-Benzox-anthene	N	N	N	N	N	SASS, LAB, LC5	2.4×10^2						
25. HETEROCYCLIC SULFUR	Benzonaphtho-thiopene	9.86×10^2	1.48×10^4	N	3.0 x 10	N	SASS, LAB, LC4	4.1×10^2	0.42	YES	1-E	1	1	1
	Thiophene	4.5×10^3	6.75×10^4	N	1.4×10^2	N	GAS, FIELD, C5	N.D.						
	Methylthiophenes	2.25×10^4	3.38×10^5	N	7.0×10^2	N	SASS, LAB, C8	N.D.						
	Benzo(b)thiophene	2.30×10^4	3.45×10^5	N	7.0×10^2	N	SASS, LAB, LC4	4.1×10^2						
	Dimethyl-thiophenes	N	N	N	N	N	SASS, LAB, C9	N.D.						
	Tri; Tetramethyl thiophenes	N	N	N	N	N	SASS, LAB, C10	N.D.						
	2,2-Bithiophene	N	N	N	N	N	SASS, LAB, LC4	4.1×10^2						
	Dibenzthiophene	N	N	N	N	N	SASS, LAB, LC4	4.1×10^2						
26. ORGANO-METALLICS A. ALKYL or ARYL	Alkyl Mercury	1.0 x 10 (.001)	1.5×10^2	2.0×10^{-4}	3.0×10^{-1}	4.0×10^{-5}	GAS, FIELD, C6	N.D.						
	Tetraethyl Lead	1.0×10^2 (.0075)	1.5×10^3	$<4.5 \times 10^1$			SASS, LAB, C12 and LC1	7.6×10^2	7.5	YES	1-E	1	1	1
	Organotin	1.0×10^2	1.0×10^3	N	3.0	N	GAS, FIELD,C6	N.D.						
	Tetramethyl Lead	1.5×10^2 (.014)	2.25×10^3	N	4.5	N	SASS, LAB, C7	N.D.						
	Organogermanes	3.15×10^4	4.73×10^5	N	9.4×10^2	N	GAS, FIELD, C6	N.D.						
	Trimethyl Arsine	N	N	N	N	N	GAS, FIELD, C5	N.D.						

*Summation of S-2-5, S-2-6 and S-2-7.

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD:
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	WHERE FOUND IN LEVEL 1	SAMPLE μg/m³ (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST	SAMPLE ALIQUOT[4]
B. SANDWICH TYPE	Nickelocene	3.5×10^3	5.25×10^4	N	1.0×10^2	N	SASS,LAB,LC4	$4.1\text{x}10^2$	0.11	NO				
	Ferrocene	5.94×10^4	8.91×10^5	N	1.8×10^3	N	GAS,FIELD,C6	N.D.						
	Dibenzene chromium	N	N	N	N	N								
C. METAL PORPHYRINS AND OTHER CHELATES	Complexed Copper	3.52×10^3	5.28×10^4	N	9.0×10	N								
	Complexed Nickel	N	N	N	N	N								
	Complexed Iron	N	N	N	N	N								
	Complexed Tin	N	N	N	N	N								
	Complexed Zinc	N	N	N	N	N								

Summation of S-2-5, S-2-6 and S-2-7.

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD:
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m³ (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
27. LITHIUM	Li	2.2×10	3.3×10^2	3.8×10^2	7.0×10^{-1}	7.5×10^{-1}	2.3×10^2	10.5	YES	1-A	1	1	1
	Li^+	2.2×10	3.3×10^2	3.8×10^2									
	LiF (as Li)	2.2×10	3.3×10^2	3.8×10^2									
	Li_2CO_3 (as Li)	2.2×10	3.3×10^2	3.8×10^2									
	LiH	2.5×10	3.8×10^2	N									
28. SODIUM	Na^+	5.3×10^4	8.0×10^5	N	1.6×10^3	N	5.7×10^4	1.0	YES	1-A	1	1	1
	NaOH	2.0×10^3	3.0×10^4	N	6.0×10	N							
29. POTASSIUM	KOH	2.0×10^3	3.0×10^4	N	6.0×10	N	2.6×10^5		YES				
	K	N	N	N	N	N							
	K^+ (as K)	N	N	2.3×10^4	N	4.6×10							
30. RUBIDIUM	Rb^{+1}	1.21×10^5	1.82×10^6	N	3.64×10^3	N	1×10^2		NO				
31. CESIUM	CS^{+1}	8.19×10^4	1.23×10^6	N	2.46×10^3	N	1.7×10		NO				
32. BERYLLIUM	Be	2.0	3.0×10	5.5×10	6.0×10^{-2}	1.1×10^{-1}	4.1	2.0	YES	1-A	1	1	1
	Be^{++}	2.0	3.0×10	5.5×10	6.0×10^{-2}	1.1×10^{-1}							
	BeO (as Be)												
	$BeO \cdot Al_2O_3 \cdot SiO_2$ (as Be)	2.0	3.0×10	5.5×10	6.0×10^{-2}	1.1×10^{-1}							
33. MAGNESIUM	Magnesium, Mg	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2	9.8×10^4	16.3	YES	1-A	1	1	1
	Magnesium Ion, Mg^{++}	6.01×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Magnesium Oxide, MgO	1.01×10^4	1.5×10^5	1.0×10^5	3.0×10^2	2.0×10^2							
	Magnesium Fluoride, MgF_2 (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Magnesium Sulfate, $MgSO_4$ (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Magnesite, $MgCO_3$ (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Dolomite, $MgCO_3 \cdot CaCO_3$ (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Asbestos (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
34. CALCIUM	Calcium Ion, Ca^{++}	1.6×10^4	2.4×10^5	1.6×10^4	4.8×10^2	3.2×10	1.3×10^6	81.0	YES	1-A	1	1	1
	Calcium Fluoride, CaF_2	N	N	N	N	N							
	Calcium Carbonate, $CaCO_3$	N	N	N	N	N							
	Calcium Sulfate, $CaSO_4$	N	N	N	N	N							
	Dolomite, $MgCO_3 \cdot CaCO_3$	N	N	N	N	N							

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS

2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN

3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH

4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE µg/m³ (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD¹	TEST EXPEC-TATIONS²	TEST COST³	SAMPLE ALIQUOT⁴
35. STRONTIUM	Strontium	3.1×10^3	4.6×10^4	N	9.2×10	N	4.3×10^3	1.4	YES	1-A	1	1	1
	Strontium Ion, Sr^{++} (as Sr)	3.1×10^3	4.6×10^4	N	9.2×10	N							
	Strontium Fluoride, SrF_2 (as Sr)	3.1×10^3	4.6×10^4	N	9.2×10	N							
	Strontium Sulfate, $SrSO_4$ (as Sr)	3.1×10^3	4.6×10^4	N	9.2×10	N							
36. BARIUM	Barium, Ba	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0	1.6×10^4	32	YES	1-A	1	1	1
	Barium Ion, Ba^{++} (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Sulfide, BaS (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Thiocarbonate, $BaCS_3$ (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Fluoride, BaF_2 (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Carbonate, $BaCO_3$ (as Ba)	5.0×10^2	5.0×10^3	8.5×10^3	1.0×10	5.0							
	Barium Sulfate, $BaSO_4$ (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
37. BORON	Boron, B	3.1×10^3	4.7×10^4	2.5×10^4	9.3×10	5.0×10	1.0×10^3	0.32	NO				
	Borate, BO_3 (as B)	3.1×10^3	4.7×10^4	2.5×10^4	9.3×10	5.0×10							
	Metaborate, BO_2^- (as B)	3.1×10^3	4.7×10^4	2.5×10^4	9.3×10	5.0×10							
	Boron Oxide, B_2O_3	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
38. ALUMINUM	Aluminum, Al	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.01	9.4×10^5	180	YES	1-A	1	1	1
	Aluminum Ion, Al^{+++}	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	N							
	Bauxite, $Al_2O_3 \cdot 3H_2O$ (as Al)	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.0							
	Hydrated Aluminum Silicate (as Al)	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.0							
	Alums $[M\,Al\,(SO_4)_2] \cdot (H_2O)_x$ (as Al)	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.0							
	Aluminum Oxide, Al_2O_3	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
39. GALLIUM	Gallium, Ga	5.0×10^3	7.4×10^4	N	1.5×10^2	N	<10		NO				
	Elemental Species, Ga	5.0×10^3	7.4×10^4	N	1.5×10^2	N							
	Gallous, Ga^{+1} (as Ga)	5.0×10^3	7.4×10^4	N	1.5×10^2	N							

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/1 HEALTH	MATE WATER μg/1 ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m³ (ppm) μg/1	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Gallic, Ga^{+3} (as Ga)	5.0×10^3	7.4×10^4	N	1.5×10^2	N	<30		NO				
	Gallium Sesquioxide, Ga_2O_3 (as Ga)	5.0×10^3	7.4×10^4	N	1.5×10^2	N							
40. INDIUM	Indium, In	1.0×10^2	1.5×10^3	N	3.0	N	<20		NO				
	Indium Ion, In^{+3}	1.0×10^2	1.5×10^3	N	3.0	N							
41. THALLIUM	Thallium, Tl	1.0×10^2	1.5×10^3	N	3.0	N	1.6×10^2	1.6	YES	1-A	1	1	1
	Thallous, Tl^{+1}	1.0×10^2	1.5×10^3	N	3.0	N							
	Thallic, Tl^{+3}	1.0×10^2	1.5×10^3	N	3.0	N							
42. CARBON	Elemental Carbon	3.5×10^3	5.3×10^4	N	1.6×10^2	N	N.D.						
	Coal	N	N	N	N	N							
	Carbide, C-	N	N	N	N	N							
	Carbonate, CO_3^{-2}	N	N	N	N	N							
	Bicarbonate, HCO_3	N	N	N	N	N							
	Carbonyl, CO=	N	N	N	N	N							
	Carbon Monoxide	4.0×10^3 (35)	6.0×10^5	6.0×10	N/A	N/A							
	Carbon Dioxide	9.0×10^6 (5000)	N	N	N/A	N/A							
43. SILICON	Silane, SiH_4	7.0×10^2	1.1×10^4	N	N	2.3×10	N.D.						
	Silicon, Si	1.0×10^4	1.5×10^5	N	3.0×10^2	N	3.5×10^6	350	YES	1-A	1	1	1
	Orthosilicate, SiO_4^{-2}	N	N	N	N	N							
	Metasilicate, SiO_3^{-2}	N	N	N	N	N							
	Silicon Dioxide, SiO_2	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
	Silicon Disulfide, SiS_2	N	N	N	N	N							
	Silicon Carbide, SiC	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
44. GERMANIUM	Germanium, Ge	5.6×10^2	8.4×10^3	N	1.7×10	N	3.2×10		NO				
	Germanous, Ge^{+2} (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germanic, Ge^{+4} (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germanous Sulfide, GeS (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germanic Sulfice, GeS_2 (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germane, GeH_4 (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germanium Oxide, GeO_2 (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued))

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	SAMPLE $\mu g/m^3$ (ppm) $\mu g/l$	RATIO SAMPLE / MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
45. TIN	Tin Oxide, SnO_2	1.0×10^4	1.5×10^5	N	3.0	N	1.9×10^2	0.02	NO				
	Tin, Sn	N	N	N	N	N							
	Stannous, Sn^{+2}	N	N	N	N	N							
	Stannic, Sn^{+4}	N	N	N	N	N							
46. LEAD	Lead, Pb	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	9.5×10^2	63	YES	1-A	1	1	1
	Elemental Led, Pb	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Plumbous, Pb^{+2}	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Plumbic, Pb^{+4} (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Monoxide, PbO (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Sulfate, $PbSO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Sulfate, Pbs (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Carbonate, $PbCO_3$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Phosphate, $Pb_3(PO_4)_2$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Chromate, $PbCrO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Molybdate, $PbMoO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Arsenate, $PbHAsO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
47. NITROGEN	Hydrazine	1.5×10^2 (.1)	2.3	N	4.5	N	N.D.						
	Alkali Cyanides, NaCN, KCN	5.0×10^3	5.0×10^2	2.5×10	1.0	5.0×10^{-2}							
	Nitric Acid, HNO_3	5.0×10^3	7.5×10^4	4.5×10^2	1.5×10^3	9.0×10^{-1}							
	Nitrogen Oxides, N_2O, NO_2, N_2O_4, N_2O_3, N_2O_5	9.0×10^3	1.4×10^5	N	N/A	N/A							
	Hydrogen Cyanide, HCN	1.1×10^4 (10)	5.0×10^2	2.5×10	1.0	5.0×10^{-2}							
	Ammonia, NH_3	1.8×10^4 (25)	2.5×10^3	5.0×10	5.0	1.0×10^{-1}	1.8×10^5	10	YES[1]	1-C	1	1	1
	Cyanogen, C_2N_2	2.0×10^4	1.0×10^3	2.5×10	2.0	5.0×10^{-2}							
	Nitride, N=	N	N	N	N	N							
	Nitrate, NO_3-	N	N	N	N	N							
	Nitrite, NO_2-	N	N	N	N	N							
	Ammonium, NH_4^+	N	N	N	N	N							

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value
1. As Anionic Species

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOP-MENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS

2. EXPECTED TEST SUCCESS
   1. HIGH
   2. MODERATE
   3. UNKNOWN

3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH

4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m^3 (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m^3 (ppm) μg/l	RATIO $\frac{\text{SAMPLE}}{\text{MATE}}$	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD^1	TEST EXPEC-TATIONS^2	TEST COST^3	SAMPLE ALIQUOT^4
48. PHOSPHORUS	Phosphorus, P	1.0×10^2	1.5×10^4	5.0×10^{-1}	3.0×10	1.0×10^{-3}	1.1×10^3	11	YES	1-C	1	1	1
	Phosphite, PO_3^{-3} (as P)	1.0×10^2	1.5×10^4	5.0×10^{-1}	3.0×10	1.0×10^{-3}							
	Biphosphate, $H_2PO_4^-$ (as P)	1.0×10^2	1.5×10^4	5.0×10^{-1}	3.0×10	1.0×10^{-3}							
	Phosphine, PH_3	4.0×10^2 (0.3)	6.0×10^3	N	N/A	N/A							
	Phosphoric Acid, H_3PO_4	1.0×10^3	1.5×10^4	4.5×10^3	3.0×10	9.0							
	Phosphorus Pentasulfide	1.0×10^3	1.5×10^4	N	3.0×10	N							
	Phosphate, PO_4^{-3}	N	N	N	N	N							
49. ARSENIC	Arsenic, As	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}	2.3×10	1.1	YES	1-A	1	1	1
	Metallic Arsenic	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsenous, As^{+3}	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsenic, As^{+5}	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsenate, AsO_4^{-3} (as As)	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsenite, AsO_3^{-3} (as As)	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsenide, As^{-3} (as As)	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsine, AsH_3	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsenic Trioxide, As_2O_3	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
50. ANTIMONY	Antimony Trioxide, Sb_2O_3	5.0×10^1	7.5×10^2	2.0×10^2 (as Sb)	1.5×10	4.0×10^{-1} (as Sb)	5.2	0.1	NO				
	Antimony Metal, Sb	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Antimonous, (stibnous) Sb^{+3}	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Antimonic (stibnic) Sb^{+5}	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Stibine, SbH_3 (as Sb)	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Antimonous Sulfide, Sb_2S_3	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Antimony, Sb	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
51. BISMUTH	Bismuth, Bi	4.1×10^2	6.1×10^3	N	1.2×10^1	N	1.7×10	0.4	NO				
	Elemental Bismuth, Bi	4.1×10^2	6.1×10^3	N	1.2×10^1	N							
	Bismuthous, Bi^{+3} (as Bi)	4.1×10^2	6.1×10^3	N	1.2×10^1	N							
	Bismuthic, Bi^{+5} (as Bi)	4.1×10^2	6.1×10^3	N	1.2×10^1	N							

TABLE KEY:

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   E. GS/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
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   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	SAMPLE $\mu g/m^3$ (ppm) $\mu g/l$	RATIO SAMPLE / MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
52. OXYGEN	Ozone, O_3	2.0 x 10^2 (0.1)	N/A	N/A	N/A	N/A	N.D.						
53. SULFUR	Rhombic Sulfur, S_8	N	N	N	N	N	2.2x10^4	N					
	Sulfide, S^{-2}	N	N	N	N	N							
	Sulfate, SO_4^{-2}	N	N	N	N	N							
	Sulfite, SO_3^{-2}	N	N	N	N	N							
	Thiocyanate, SCN^-	N	N	N	N	N							
	Sulfur Trioxide, SO_3	N	N	N	N	N							
	Sulfuric Acid, H_2SO_4	1.0 x 10^3	1.5 x 10^4	4.5 x 10^2	3.0 x 10^1	9.0 x 10^2	N.D.						
	Sulfur Dioxides, SO_2	1.3 x 10^4	2.0 x 10^5	N	4.0 x 10^2	N	N.D.						
	Hydrogen Sulfide, H_2S	1.5 x 10^4 (10)	2.3 x 10^4	1.0 x 10^1	N/A	N/A	N.D.						
	Carbon Disulfide, CS_2	6.0 x 10^4 (20)	9.0 x 10^5	1.0 x 10^4	N/A	N/A	N.D.						
	Carbonyl Sulfide, COS	4.4 x 10^5	N/A	N/A	N/A	N/A	N.D.						
54. SELENIUM	Selenium, Se	2.0 x 10^2	5.0 x 10^1	2.5 x 10^1	1.0 x 10^{-1}	5.0 x 10^{-2}	7.5	0.04	NO				
	Elemental Selenium, Se	2.0 x 10^2	5.0 x 10^1	2.5 x 10^1	1.0 x 10^{-1}	5.0 x 10^{-2}							
	Selenide, Se^{-2}	2.0 x 10^2	5.0 x 10^1	2.5 x 10^1	1.0 x 10^{-1}	5.0 x 10^{-2}							
	Selenites, SeO_3^{-2} (as Se)	2.0 x 10^2	5.0 x 10^1	2.5 x 10^1	1.0 x 10^{-1}	5.0 x 10^{-2}							
	Selenates, SeO_4^{-2} (as Se)	2.0 x 10^2	5.0 x 10^1	2.5 x 10^1	1.0 x 10^{-1}	5.0 x 10^{-2}							
	Hydrogen Selenide, H_2Se	2.0 x 10^2 (.05)	5.0 x 10^1 (as Se)	2.5 x 10^1 (as Se)	1.0 x 10^{-1} (as Se)	5.0 x 10^{-2} (as Se)							
	Carbon Diselenide, CSe_2 (as Se)	2.0 x 10^2	5.0 x 10^1	2.5 x 10^1	1.0 x 10^{-1}	5.0 x 10^{-2}							
	Selenium Dioxide, SeO_2 (as Se)	2.0 x 10^2	5.0 x 10^1	2.5 x 10^1	1.0 x 10^{-1}	5.0 x 10^{-2}							
55. TELLURIUM	Tellurium, Te	1.0 x 10^2	1.5 x 10^3	N	3.0 x 10	N	<5.5		NO				
	Telluride, Te^{-2}	1.0 x 10^2	1.5 x 10^3	N	3.0 x 10	N							
	Tellurite, TeO_3^{-2} (as Te)	1.0 x 10^2	1.5 x 10^3	N	3.0 x 10	N							
	Tellurate, TeO_4 (as Te)	1.0 x 10^2	1.5 x 10^3	N	3.0 x 10	N							
56. FLUORIDE	Fluoride Ion, F^-	2.5 x 10^3	3.8 x 10^4	N	7.5 x 10^1	N	N.D.						
	Hydrogen Fluoride, HF	2.0 x 10^3	3.0 x 10^4	N	N/A	NA	N.D.						

TABLE KEY:

1. TEST METHOD
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   2. DEVELOPMENTAL
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   A. AAS
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   C. WET CHEMICAL
   D. ESCA
   E. GS/MS
2. EXPECTED TEST SUCCESS
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	SAMPLE $\mu g/m^3$ (ppm) $\mu g/l$	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
57. CHLORINE	Chloride Ion, Cl^-	N	1.3×10^6	N	2.6×10^3	N	1.6×10^4	N					
	Hypochlorite, ClO^-	N	N	N	N	N							
	Chlorite, ClO_2^-	N	N	N	N	N							
	Chlorate, ClO_3	N	N	N	N	N							
	Chlorine Dioxide, ClO_2	N	N	N	N	N							
	Carbonyl Chloride (phosgene), $COCl_2$	4.0×10^2	6.0×10^3	N	N/A	N/A	N.D.						
	Hydrogen Chloride, HCl	7.0×10^3	1.1×10^5	N	N/A	N/A	N.D.						
58. BROMINE	Bromide Ion, Br^-	N	N	N	N	N	10.6	N					
	Bromide Ion, Br^-	N	N	N	N	N							
	Hydrogen Bromide, HBr	1.0×10^4	1.5×10^5	N	N/A	N/A	N.D.						
59. IODINE	Iodide Ion, I^-	N	N	N	N	N	1.1×10	N					
60. SCANDIUM	Scandium, Sc	5.3×10^4	8.0×10	N	1.6×10^{-2}	N	5.6×10^2						
	Scandium Ion, Sc^{+3}	5.3×10^4	8.0×10	N	1.6×10^{-2}	N							
61. YTTRIUM	Yttrium Ion, Y^{+3}	1.0×10^3	1.5×10^4	N	3.0×10^1	N	8.5×10^3	0.85	YES	1-C	2	1	2
62. TITANIUM	Titanium, Ti	6.0×10^3	9.0×10^4	8.2×10^2 (as $Ti[SO_4]_2$)	1.8×10^2	1.6×10	2.7×10^4	4.5	YES	1-C	1	1	1
	Titanous, Ti^{+3} (as Ti)	6.0×10^3	9.0×10^4	8.2×10^2	1.8×10^2	1.6×10							
	Titanic, Ti^{+4} (as Ti)	6.0×10^3	9.0×10^4	8.2×10^2	1.8×10^2	1.6×10							
	Titanium Dioxide, TiO_2 (as Ti)	6.0×10^3	9.0×10^4	8.2×10^2	1.8×10^2	1.6×10							
63. ZIRCONIUM	Zirconium Ion, Zr^{+4}	5.0×10^3	7.5×10^4	N	1.5×10^1	N	3.5×10^3	0.7	YES	1-C	1	1	2
	Zirconium Dioxide, ZrO_2 (as Zr)	5.0×10^3	7.5×10^4	N	1.5×10^1	N							
64. HAFNIUM	Hafnium Ion, Hf^{+4}	5.0×10^2	7.5×10^4	N	1.5×10	N	3.6×10		NO				
65. VANADIUM	Vanadium, V	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}	9.8×10^3	19.6	YES	1-A	1	1	1
	Elemental Vanadium, V	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadic, V^{+3} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadyl, Vo^{+2} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Orthovanadate, VO_4^{-4} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							

*Summation of S-2-5, S-2-6, and S-2-7

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
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   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE µg/m^3 (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Metavanadate, VO_3^- (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadylic, VO^{+3} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Monoxide, VO (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Trioxide, V_2O_3 (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Tetraoxide, V_2O_4, (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Pentoxide, V_2O_5 (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Carbide, VC (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Monosulfide, VS (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Nitride, VN (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadyl Sulfate, $VOSO_4 \cdot 5H_2O$ (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
66. NIOBIUM	Niobus, Nb^{+3}	2.2×10^4	3.3×10^5	N	6.5×10^2	N	8.6x10		NO				
	Niobic, Nb^{+5}	2.2×10^4	3.3×10^5	N	6.5×10^2	N							
	Niobium Oxides, NbO, Nb_2O_5 (as Nb)	2.2×10^4	3.3×10^3	N	6.5×10^2	N							
67. TANTALUM	Tantalum Ion, Ta^{+5}	5.0×10^3	7.5×10^4	N	1.5×10^2	N	3.7x10		NO				
68. CHROMIUM	Chromium, Cr	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	2.1×10^3	210	YES	1-C	1	1	1
	Chromous, Cr^{+2} (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromic, Cr^{+3} (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromates, CrO_4^{-2} (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromites, $Cr_2O_4^{-2}$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Dichromates, $Cr_2O_7^{-2}$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromium Carbonyl, $Cr(CO)_6$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	N.D.						
	Chromium Sulfide, Cr_2S_3	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromic Oxide, Cr_2O_3 (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromite Mineral, FeO Cr_2O_3 (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							

TABLE KEY

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   E. GC/MS
2. EXPECTED TEST SUCCESS:
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   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
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   1. ADEQUATE
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   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6, and S-2-7

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	SAMPLE $\mu g/m^3$ (ppm)[2] $\mu g/l$	RATIO $\frac{\text{SAMPLE}}{\text{MATE}}$	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Hydrous Chromium Phosphate, $CrPO_4$ XH_2O (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Iron Chromate, $FeCrO_4$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
69. MOLYBDEN	Molybdenum, Mo	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1	3.7×10^2	0.07	NO				
	Molybdenous, Mo^{+2}	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdic, Mo^{+3}	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdate, MoO_4^{-2} (as Mo)	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdenum Sulfide, MoS_2 (as Mo)	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdenum Trioxide, MoO_3 (as Mo)	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
70. TUNGSTEN	Tungsten, W	1.0×10^3	1.5×10^4	N	3.0×10^1	N	1×10		NO				
	Tungsten Ions, W^{+2}, W^{+4}, W^{+5}, W^{+6}, WO_4^{-2}	N	N	N	N	N							
	Tungsten Disulfide, WS_2 (as W)	1.0×10^3	1.5×10^4	N	3.0×10^1	N							
	Wolframite Mineral, $FeWO_4 \cdot MnWO_4$ (as W)	1.0×10^3	1.5×10^4	N	3.0×10^1	N							
71. MANGANESE	Manganese, Mn	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}	3.8×10^3	6.76	YES	1-A	1	1	1
	Manganous, Mn^{+2}	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganic, Mn^{+3}	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Permanganate, MnO_4^- (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganous Oxide, MnO (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganese Dioxide, MnO_2 (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganese Carbonate, $McCO_3$ (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganous Sulfate, $MnSO_4$ (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganese Sulfide, MnS_2 (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
72. IRON	Iron Carbonyls, $Fe(CO)_5$, $Fe(CO)_9$, $FE_3(CO)_{12}$	7.0×10^2	1.1×10^4	N	2.1×10^1	N	N.D.						
	Ferrous, Fe^{+2}	1.0×10^3	1.5×10^3	2.5×10^2	3.0×10	5.0×10^{-1}	4.3×10^5	456	YES	1-A	1	1	1
	Ferric, Fe^{+3}	1.0×10^3	1.5×10^3	2.5×10^2	3.0×10	5.0×10^{-1}							
	Ferrous Oxide, FeO	5.0×10^3	7.5×10^4	N	1.5×10^2	N							

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   3. UNKNOWN

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   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6, and S-2-7

N.D. Not Determined
N No Value

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m³ (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD¹	TEST EXPEC-TATIONS²	TEST COST³	SAMPLE ALIQUOT⁴
	Magnetite, $FeO \cdot Fe_2O_3$	9.3×10^3	6.2×10^3	N	3.8×10^1	N							
	Ferrocyanide, $Fe(CN)_6^{-4}$	N	N	N	N	N							
	Ferricyanide, $Fe(CN)_6^{-3}$	N	N	N	N	N							
	Ferric Oxide, Fe_2O_3	N	N	N	N	N							
	Ferric Hydroxide (hydrated) $Fe_2O_3 \cdot XH_2O$	N	N	N	N	N							
	Iron Sulfides, FeS, Fe_2S_3	N	N	N	N	N							
	Pyrite, FeS_2	N	N	$>1.0 \times 10^5$	N	2.0×10^2							
	Potassium Iron Silicate, $KFeSi_2O_6$	N	N	N	N	N							
73. RUTHENIUM	Ruthenium Ion, Ru^{+3}	N	N	N	N	N	<9	N					
74. COBALT	Cobalt, Co	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}	1.9×10^2	3.8	YES	1-C	1	1	1
	Cobaltous, Co^{+2}	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobaltic, Co^{+3}	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobaltous Carbonate, hydrated, $CoCO_3 \cdot H_2O$ (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Carbide, Co_3C (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Sulfides, CoS, Co_2S_3 (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Arsenic Sulfide, CoAsS (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Arsenide, $CoAs_2$ (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Carbonyl, $Co(CO)_4$ (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}	N.D.						
	Cobaltous Oxide, CoO (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobaltous Hydroxide, $Co(OH)_2$ (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
75. RHODIUM	Rhodium Ion, Rh^{+3}	1.0×10	1.5×10^1	N	3.0×10^{-2}	N	2.1×10^2	21	YES	1-C	1	1	1
76. NICKEL	Nickelous, Ni^{+2}	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}	3.8×10^3	250	YES	1-A	1	1	1
	Nickelic, Ni^{+3}	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							
	Nickelous Sulfide, NiS (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Arsenide, NiAs (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

TABLE KEY

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m³ (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD¹	TEST EXPECTATIONS²	TEST COST³	SAMPLE ALIQUOT⁴
	Nickel Oxide, NiO (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Antimonide, NiSb (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Arsenic Sulfide, NiAsS (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Carbonyl, $Ni(CO)_4$	4.3×10^1	6.5×10^2	1.0×10^1 (as Ni)	1.0×10	2.0×10^{-3}	N.D.						
77. PLATINUM	Elemental Platinum, Pt	2.0×10	3.0×10^1	N	6.0×10^{-2}	N	<5		NO				
78. COPPER	Copper	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}	9.7×10^2	4.9	YES	1-A	1	1	1
	Cuprous, Cu^+	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Cupric, Cu^{+2}	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Copper Fluoride, CuF_2 (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Copper Oxides, CuO, Cu_2O (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-5}							
	Copper Sulfate, $CuSO_4$ (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Copper Sulfides, CuS, Cu_2S (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Copper Carbonate, $CuCO_3$ (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Malachite Mineral, $CuCO_3 \cdot Cu(OH)_2$ (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Chalcopyrite Mineral, $CuFeS_2$	N	N	N	N	N							
79. SILVER	Silver, Ag	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	<1	N					
	Silver Ion, Ag^+ (as Ag)	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	< 5x10		NO				
	Silver Chloride, AgCl (as Ag)	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Silver Cyanide, AgCN (as Ag)	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Silver Sulfide, Ag_2S (as Ag)	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
80. GOLD	Elemental Gold	N	N	N	N	N							
81. ZINC	Zinc, Zn	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							
	Elemental Zinc, Zn	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							
	Zinc Ion, Zn^{+2}	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							
	Zinc Oxide, ZnO (as Zn)	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

TABLE KEY:

1. TEST METHOD
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   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-2. Total Emission Data From 6-inch FBC Unit* (Concluded)

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE µg/m^3 (ppm) µg/l	RATIO SAMPLE / MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Zinc Sulfate, $ZnSO_4$ (as Zn)	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							
	Zinc Sulfide, ZnS (as Zn)	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							
82. CADMIUM	Cadmium, Cd	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
	Elemental Cadmium, Cd	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}	$<6 \times 10$	6	YES	1-A	1	1	1
	Cadmium Ion, Cd^{+2}	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
	Cadmium Sulfide, CdS (as Cd)	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
	Cadmium Oxide, CdO (as Cd)	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
83. MERCURY	Mercury, Hg	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Elemental Mercury, Hg	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}	1×10	0.2	NO				
	Mercurous, Hg_2^{++}	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercuric, Hg^{++}	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercuric Sulfide, HgS	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercuric Chloride, $HgCl_2$	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
84. CERIUM	Dysprosium, Dy (Dy^{+3})	9.3×10^3	2.3×10^5	N	4.6×10^2	N							
	Cerium, Ce (Ce^{+3}, Ce^{+4}, Ce_2O_3)	3.7×10^4	5.5×10^5	N	1.1×10^3	N	1.6×10^3	0.04	NO				
	Praseodymium, Pr (Pr^{+3})	5.1×10^4	7.7×10^5	N	1.5×10^3	N							
	Samarium, Sm (Sm^{+3})	5.3×10^4	7.9×10^5	N	1.6×10^3	N							
	Lanthanum, La	1.1×10^5	1.7×10^6	N	3.4×10^3	N							
	Neodymium, Nd (Nd^{+3})	N	N	N	N	N							
85. URANIUM	Uranium, U (U^{+6})	9.0×10	6.0×10^4	$5,0 \times 10^2$	1.2 x 102	1.0×10	6.4×10	0.7	YES	1-C	1	1	1
86. THORIUM	Thorium, Th (Th^{+4})	4.2×10^2	6.3×10^3	N	1.3×10	N	1.6×10^2	0.39	YES	1-C	1	1	1

*Summation of S-2-5, S-2-6 and S-2-7

N.D. Not Determined
N No Value

TABLE KEY:

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   3. UNKNOWN

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   E. GC/MS
2. EXPECTED TEST SUCCESS:
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   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 2-3. Summary of Required Level 2 Analysis

		MEG Category Number Requiring Level 2 Analyses by LC Fraction									
	FBC Sample	LC 1	LC 2	LC 3	LC 4	LC 5	LC 6	LC 7	LC 8	Inorganics	Level II Leachate Studies
Assessment of Individual FBC Samples	S-2-3, Overflow Bed Material >325 Mesh	26	2,16,21,22	16,21,22			8,10,13,19,23	8,10,19,20	8	Li, Na, K, Mg, Sr, Ba, Aℓ, Ge, Sn, Pb, P, As, S, Se, Ti, V, Cr, Fe, Rh, Ni, Pt, Cu, Ag, Cd, Hg	2, 8, 10, 13, 16, 19, 20, 21, 22, 23, 26, Li, Na, K, Mg, Sr, Ba, Aℓ, Ge, Sn, Pb, P, As, S, Cℓ, Br, F, I, Se, Tℓ, V, Cr, Fe, Rh, Ni, Pt, Cu, Ag, Cd, Hg.
	S-2-4 Bed Material Ash - 325 Mesh	26	21,22	21,22						Na, K, Mg, Ca, Si, Pb, As, S, Cℓ, Cr, Fe, Rh, Cu	21, 22, 26, Na, K, Mg, Cr, Si, Pb, As, S, Cℓ, Cr, Fe, Rh, Cu
	S-2-5 Sludge Sample	26	2,16,21,22	16,21,22			10,23	10,20		Li, Na, K, Mg, Ca, Ba, Aℓ, Sn, Pb, N, As, S, Se, Cℓ, Ti, V, Cr, Fe, Rh, Ni, Cu, Cd, Hg	
	S-2-6, >27µ Particulate	26	2,16,21,22	16,21,22			10,23	10,20		Li, Na, K, Be, Mg, Ca, Sr, Ba, Aℓ, C, Si, Pb, N, P, As, Se, S, Cℓ, Ti, Zr, V, Cr, Mn, Fe, Co, Rh, Ni, Pt, Cu, Ag, Cd, Hg	
	S-2-7, <27µ Particulate	26	2,16,21,22	16,21,22			10,19,23	10,19,20	8	Na, K, Ca, Aℓ, Si, P, As, S, Ti, V, Cr, Fe, Ni, Hg	
	S-2-9, FLUE* Gas Sample (Level 2 sample not available)	26	2,16,21	16,21	17	12,17	10,13,19,23	10,19,20	8		
Assessment of Total Emission Data (Table 1-2)	S-2-5, S-2-6 and S-2-7	26	2,15,16,22	16,21,22	25		10,13,23	10,19,20		Li, Na, K, Be, Mg, Ca, Sr, Ba, Aℓ, Tl, Si, Pb, N, P, As, Y, Ti, Zr, V, Cr, Mn, Fe, Co, Ph, Ni, Cd, U, Th	

*Level 2 Sampling Effort Required

analytical scheme, both neat samples and leachates, to generate organic compound input information and MATE inorganic water impact data.

The complete details of the sample preparation and Level 2 analytical results are contained in the following sections of this volume.

2.3 PROBLEMS ANTICIPATED IN USING THE PROVIDED PARTICULATE SAMPLES FOR THE LEVEL 2 APPROACH EVALUATION

Some specific problem areas, which had been anticipated in using the remaining run No. 2 particulate samples as a Level 2 methodology evaluation, were identified prior to analyses. The problem areas were:

- The emission samples were all hot zone particulates. Their organic contents were expected to be low.
- A SASS was not used. Therefore, an organic module and condensate were not available for Level 2 evaluation. This combined with the above point would mean that insufficient quantities of organics would be present for a proper evaluation of the Level 2 organic approach.
- The samples were approximately 8 months old. It is not specifically known what changes take place in environmental samples in storage for this period of time. Therefore, their Level 2 assessment may not be representative of one conducted much closer to their collection date.
- Sufficient quantities of samples were not available to conduct replicate analyses or to conduct some specific inorganic tests. Also sample quantities extracted for organic analyses would have been much larger (at least a factor of 2) had more sample been available.

In spite of the above list of problems, valuable environmental assessment information was gathered from analyzing these samples. These were: evaluation and modification of the Level 2 approach developed earlier in this project and presented in the reference text, the identification of those analytical techniques which require further optimization and a Level 2 characterization of the Battelle FBC samples.

2.4 DETAILS OF LEVEL 2 ALLOCATION PLAN

Table 2-4 contains an inventory of the provided samples and the general disbursement plan. In one case, the particulate $<27\mu$, the provided quantity was lower than had been documented by Battelle as being sent for analysis.

The S-2-5 sludge sample was provided as dried solids. This sample, the S-2-4 Overflow Bed Material -325 mesh, and the particulate $<27\mu$ all were provided in too small a quantity for their inclusion in Level 2 leachate studies.

Table 2-4. Sample Inventory and General Disbursement Plan

Sample Number	Description	Total Quantity (g)	Organic (g)*	Inorganic (g)	Dilute Acid Leachate (g)	Dilute Base Leachate (g)
S-2-1	Illinois Coal No. 6	10.0	4.0138	2.0	2.0	2.0
S-2-2	Grove Limestone	16.0	3.9991	4.0	4.0	4.0
S-2-3	Overflow Bed Material >325 mesh	20.0	9.9820	4.0	3.0	3.0
S-2-4	Overflow Bed Material -325 mesh	∿0.7	0.3605	Remainder		
S-2-5	Sludge	6.0	3.9652	Remainder		
S-2-6	Particulates >27μ	8.0	3.9355	2.0	1.0	1.0
S-2-7 (-2 and -3)	Particulates <27μ	0.90	0.5335	Remainder		

*Actual Sample Allocated

3. LEVEL 2 INORGANIC CHARACTERIZATION OF THE FLUIDIZED BED COMBUSTOR PARTICULATES

The Fluidized Bed Combustor samples were all particulates. The inorganic Level 2 approach was followed as completely as possible for the limited quantities provided. The logic flow charts published as a guide to the analyst in the "Approach to Level 2 Analysis Based on Level 1 Results, MEG Categories and Compounds and Decision Criteria" were the focal point for the compound identification matrix utilized. These flow charts coordinate the use of a variety of analytical techniques. Acidic and basic leachates were prepared for cation leachability assessment from samples: Illinois coal (S-2-1), Grove limestone (S-2-2), the overflow bed material (S-2-3), and the particulates >27μ (S-2-6). The following section contains the details of sample preparation, instruments utilized, and the information obtained for each phase of this inorganic Level 2 effort. The reference text should be used by the reader for the theoretical background on each analytical technique.

3.1 INITIAL SAMPLE CHARACTERIZATION (Refer to Figure 3-1)

The Level 1 elemental data have been tabulated and summarized in Section 1. Unfortunately anion data (other than the common elements which form anions) were not available from this modified Level 1 assessment. This was unfortunate not only from the standpoint of drafting a potential Level 2 compound list but also because insufficient quantities of samples were available to conduct quantitative Level 2 anion analysis although qualitative techniques were applied. However, a list of potential emitted compounds was drafted based on knowledge of the process stream and sampling conditions.

3.1.1 List of Potential Inorganic Compounds

For the Battelle FBC samples, the air feed rate (87.3 lb/hr) produces an oxidizing condition for the bed material and stack effluent. The coal

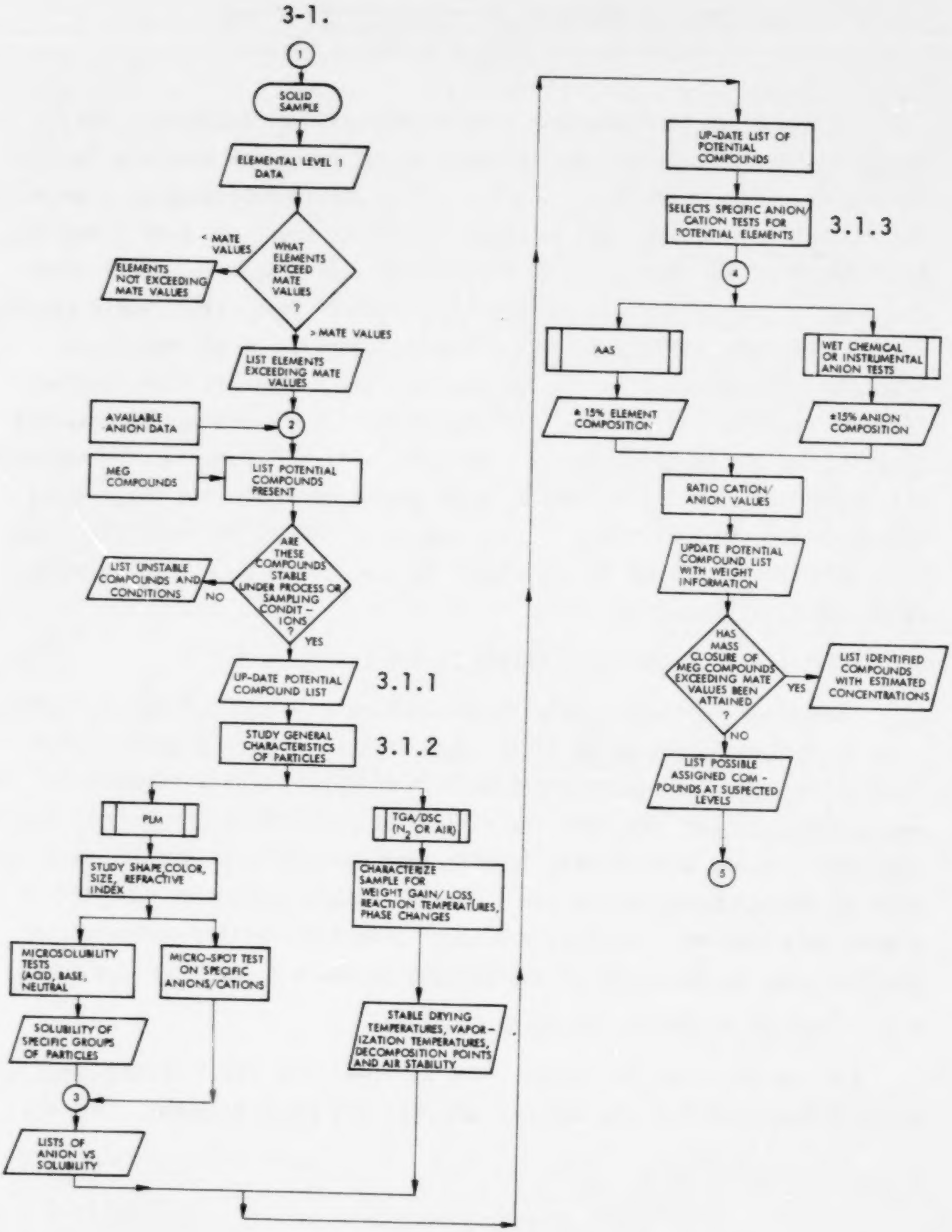

3-1.
1
SOLID SAMPLE
ELEMENTAL LEVEL 1 DATA
WHAT ELEMENTS EXCEED MATE VALUES ?
< MATE VALUES
ELEMENTS NOT EXCEEDING MATE VALUES
> MATE VALUES
LIST ELEMENTS EXCEEDING MATE VALUES
AVAILABLE ANION DATA
2
MEG COMPOUNDS
LIST POTENTIAL COMPOUNDS PRESENT
ARE THESE COMPOUNDS STABLE UNDER PROCESS OR SAMPLING CONDIT-IONS ?
NO
LIST UNSTABLE COMPOUNDS AND CONDITIONS
YES
UP-DATE POTENTIAL COMPOUND LIST
3.1.1
STUDY GENERAL CHARACTERISTICS OF PARTICLES
3.1.2
PLM
TGA/DSC (N_2 OR AIR)
STUDY SHAPE, COLOR, SIZE, REFRACTIVE INDEX
CHARACTERIZE SAMPLE FOR WEIGHT GAIN/ LOSS, REACTION TEMPERATURES, PHASE CHANGES
MICROSOLUBILITY TESTS (ACID, BASE, NEUTRAL
MICRO-SPOT TEST ON SPECIFIC ANIONS/CATIONS
SOLUBILITY OF SPECIFIC GROUPS OF PARTICLES
STABLE DRYING TEMPERATURES, VAPOR-IZATION TEMPERATURES, DECOMPOSITION POINTS AND AIR STABILITY
3
LISTS OF ANION VS SOLUBILITY
UP-DATE LIST OF POTENTIAL COMPOUNDS
SELECTS SPECIFIC ANION/ CATION TESTS FOR POTENTIAL ELEMENTS
3.1.3
4
AAS
WET CHEMICAL OR INSTRUMENTAL ANION TESTS
± 15% ELEMENT COMPOSITION
±15% ANION COMPOSITION
RATIO CATION/ ANION VALUES
UPDATE POTENTIAL COMPOUND LIST WITH WEIGHT INFORMATION
HAS MASS CLOSURE OF MEG COMPOUNDS EXCEEDING MATE VALUES BEEN ATTAINED ?
YES
LIST IDENTIFIED COMPOUNDS WITH ESTIMATED CONCENTRATIONS
NO
LIST POSSIBLE ASSIGNED COM-POUNDS AT SUSPECTED LEVELS
5

Figure 3-1. Logic Flow Chart for Initial Sample Characterization

emitted SO_2 forms metallic sulfide, sulfite and sulfate compounds under FBC operating conditions. In general oxides, sulfur species, carbonates and some nitrate are the expected compound classes. Thefore, the potential list of compounds based on the Level 1 elemental inorganic data of the total emission samples, MEG list and process conditions is as follows:

Li, Li^+, Li_2CO_3

Na^+

K^+

Be^{++}, BeO, $BeO \cdot Al_2O_3 \cdot SiO_2$

Mg^{++}, MgO, $MgSO_4$, $MgCO_3$, $MgCO_3 \cdot CaCO_3$

Ca^{++}, $CaCO_3$, $CaSO_4$, $MgCO_3 \cdot CaCO_3$

Sr^{++}, $SrSO_4$

Ba, $BaCO_3$, $BaSO_4$

Al^{+3}, $Al_2O_3 \cdot 3H_2O$, Al_2O_3

Tl

SiO_4^{-2}, SiO_3^{-2}, SiO_2, SiC

Pb^{+2}, Pb^{+4}, PbO, $PbSO_4$, $PbCO_3$, $Pb_3(PO_4)_2$, $PbCrO_4$

PO_4^{-3}, PO_3^{-3}

As^{+3}, As^{+5}, AsO_4^{-3}, AsO_3^{-3}, As_2O_3

S^{-2}, SO_4^{-2}, SO_3^{-2}

Y^{+3}

Ti^{+3}, Ti^{+4}, TiO_2

Zr^{+4}, ZrO_2

V^{+3}, VO^{+2}, VO_4^{-4}, VO_3, VO^{+3}, VO, V_2O_3, V_2O_4, V_2O_5, $VOSO_4 \cdot 5H_2O$

Cr^{+2}, Cr^{+3}, CrO_4^{-2}, $Cr_2O_4^{-2}$, $Cr_2O_7^{-2}$, Cr_2O_3, FeO Cr_2O_3, $FeCrO_4$

Mn^{+2}, Mn^{+3}, MnO_4, MnO, MnO_2, $MnCO_3$, $MnSO_4$

Fe^{+2}, Fe^{+3}, FeO, $FeO \cdot Fe_2O_3$, Fe_2O_3, $K\ FeSi_2O_6$

Co^{+2}, Co^{+3}, $CoCO_3 \cdot 4H_2O$, CoO

Rh^{+3}

Ni^{+2}, Ni^{+3}, NiO

Cu^{+}, Cu^{+2}, CuO, Cu_2O, $CuSO_4$, $CuCO_3$

Cd^{+2}, CdO

Hg^{++}, HgCl

U

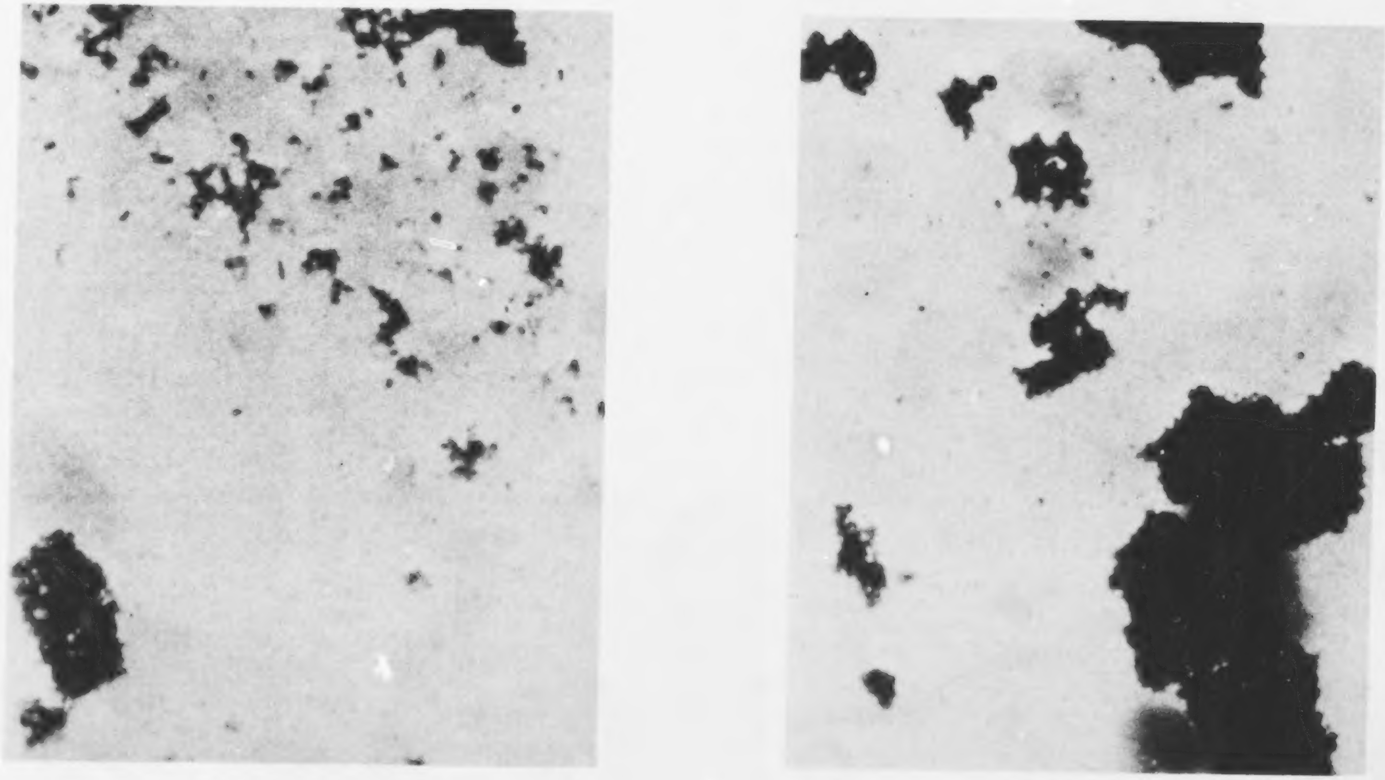
Th

In most cases, e.g., Na^{+}, K^{+}, Y^{+3}, Rh^{+3}, U, and Th based on the current MEG list, only elemental concentration data are necessary in the Level 2 analysis scheme.

3.1.2 Study of General Characteristics

The FBC particulate samples were examined by polarized light microscopy (PLM) (Figures 3-2 through 3-5). Representative photomicrographs at 42X were made. The samples were mounted on glass slides and illuminated from the top.

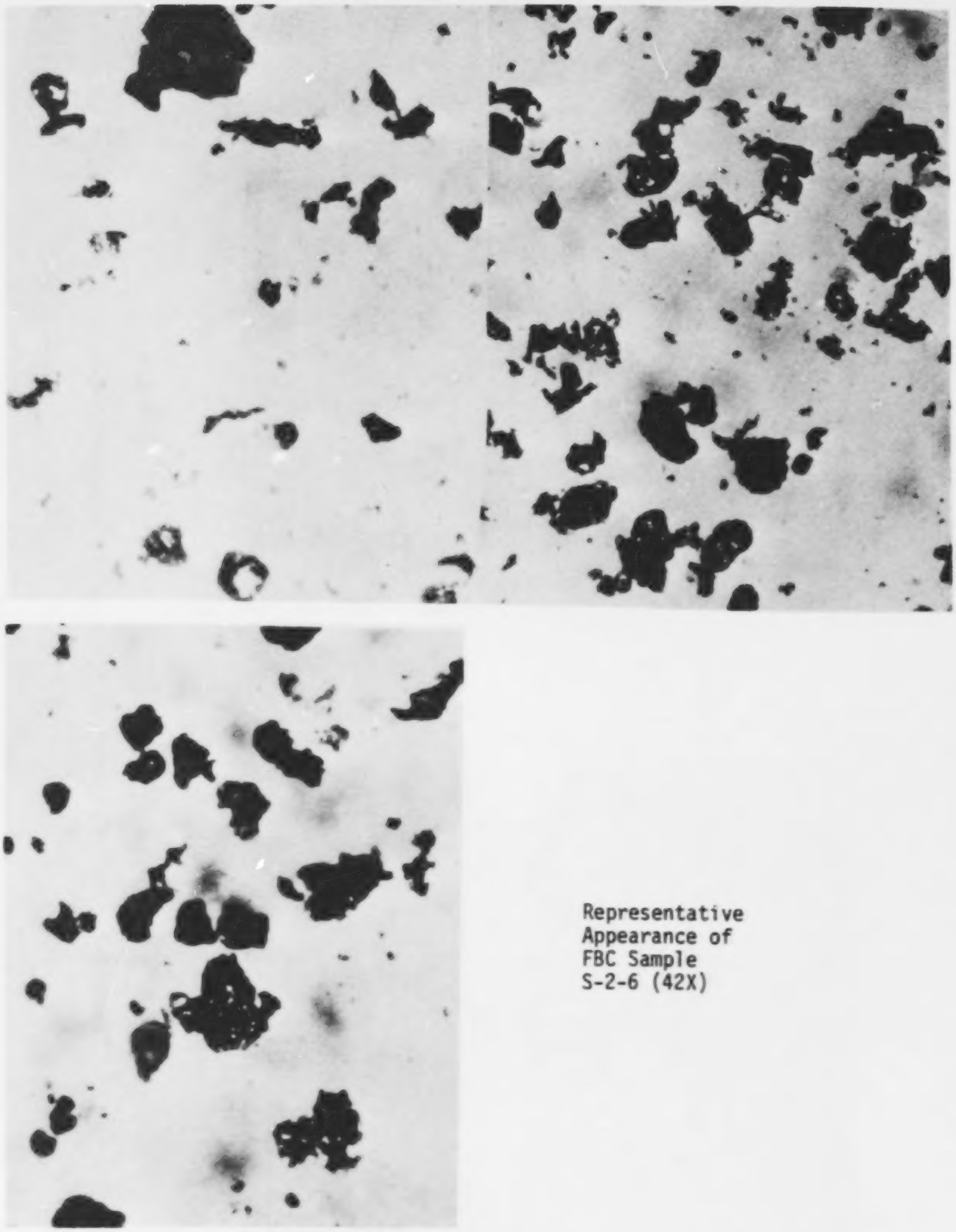
The coal feed (S-2-1) and the >27μ particulate (S-2-6) contain the same types of amorphous materials. The bulk of the particles are gray or black in color. The size range of these particles in the >27μ fraction varies up to approximately 200μ. A white opaque material accounts for about 5 percent of the material observed. There are also traces of a yellow substance which ranges in size up to 100μ and a bright red-yellow material which varied in size in the particulate catch from 15μ to 125μ. This visual observation may indicate incomplete combustion of the coal feed fines.



S-2-4

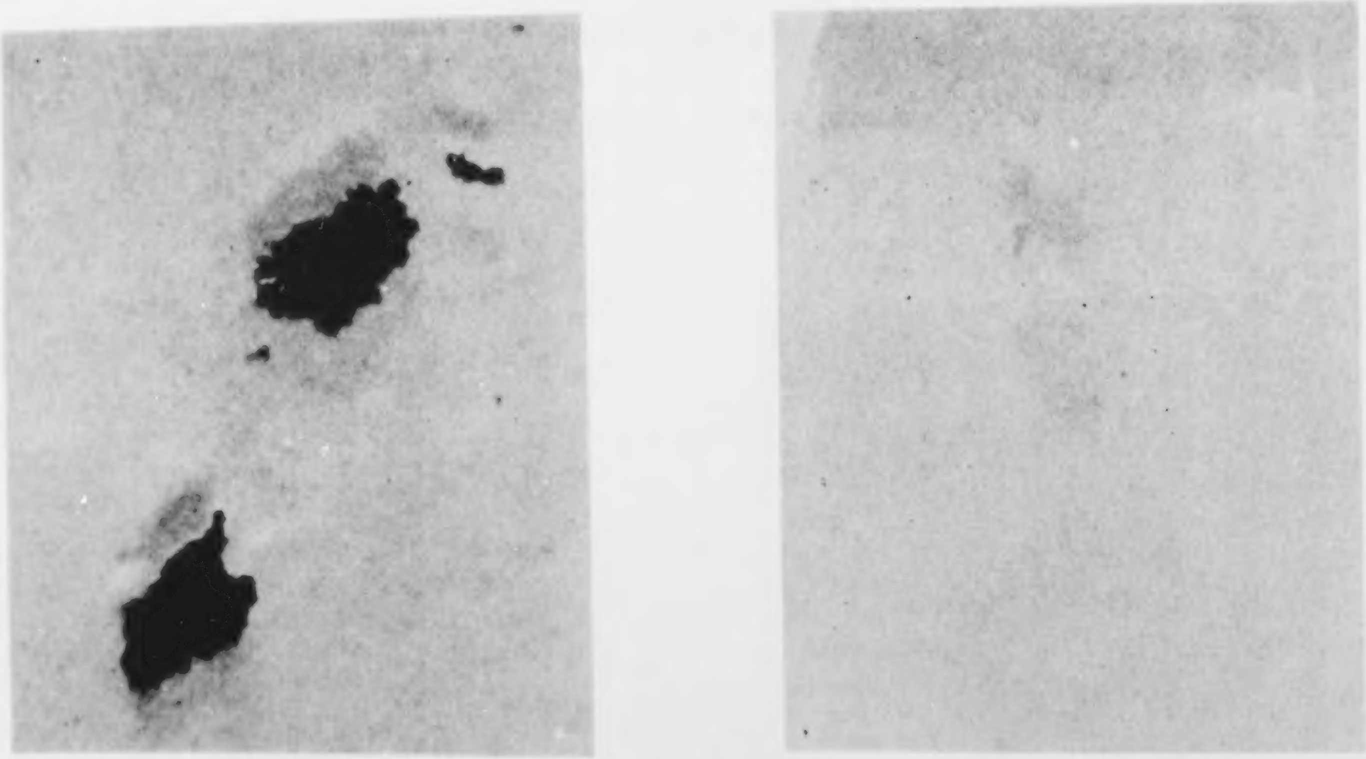
S-2-5

Figure 3-2. Photomicrograph of FBC Samples, S-2-4 and S-2-5



Representative
Appearance of
FBC Sample
S-2-6 (42X)

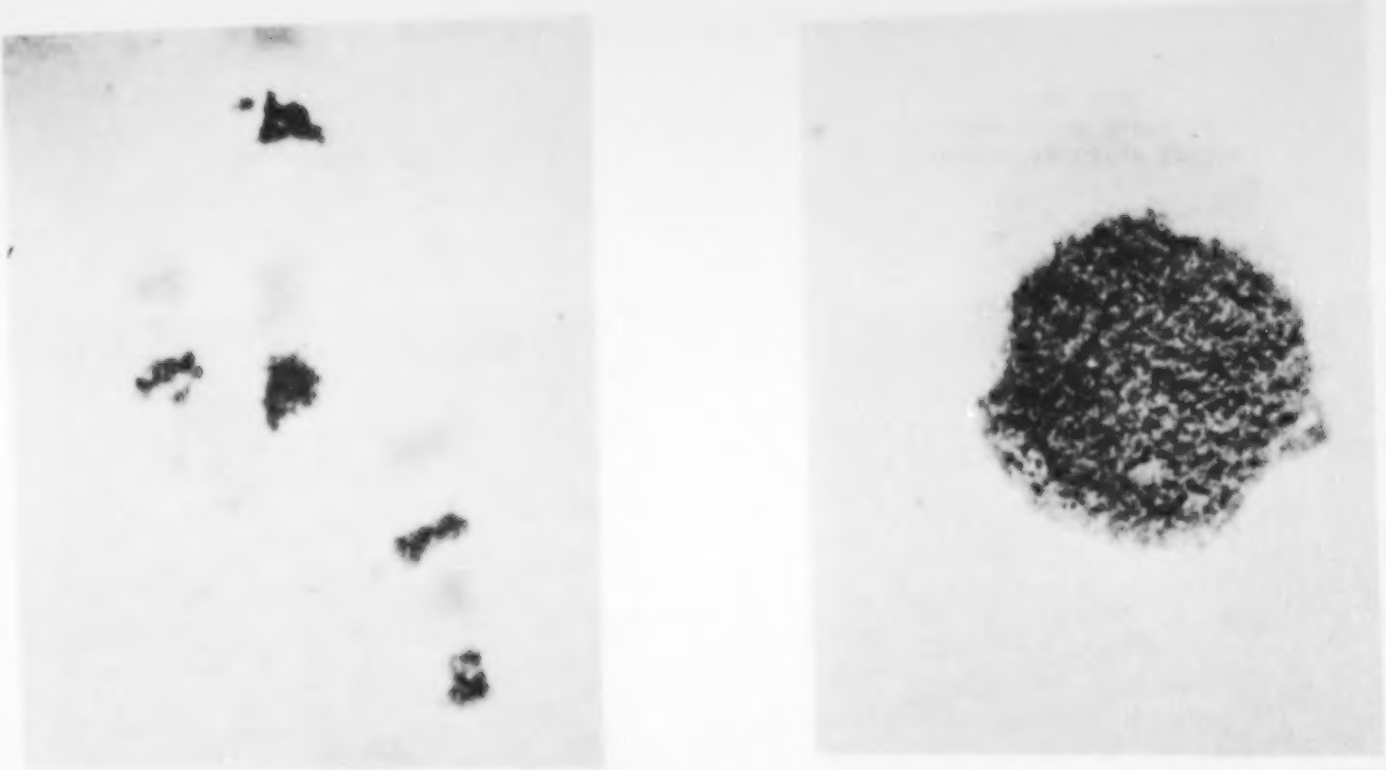
Figure 3-3. Photomicrograph of Sample S-2-6



Representative
Appearance

Unusually Large Yellow
Amorphous Particle
(Two Seen)

Figure 3-4. Photomicrograph of Sample S-2-7



(42X)

Size Variation of Agglomerates Observed

Figure 3-5. Photomicrograph of Sample S-2-7

The overflow bed, sludge, and the particulate samples (S-2-4-1, S-2-5, S-2-7-2 and S-2-7-3) were agglomerates of gray and sand colored materials. The smallest cluster, and some individual particles, were about 15μ in diameter. There were also traces of white and red materials.

S-2-7-2 contained some unusually large materials, which are described below:

Color	Shape	Size (μ)	Comments
White, opaque	Trapezoidal	150 x 220	Observed numerous parallel lines in particle, suggest crystalline material
Yellow	Rectangular	90 x 100 230 x 305	

This sample also contained a few long, narrow rod like objects all about 500μ x 40μ.

S-2-7-3 contained traces of fibrous appearing material and bright, shiny, maybe metallic particles.

The bulk of particles in the emission samples S-2-5, S-2-6 and S-2-7 were uniform in character and comparable to one another.

When the sample history is well known, an analyst can determine if the unusual particulates are sample or contaminants introduced through sampling, transfer or storage. This technique then becomes a very valuable quality assurance tool.

Microsolubility and microspot tests were not conducted.

Another technique used in the study of a solid particulate's general characteristics is Thermal Analysis. This includes Thermal Gravimetric Analysis (TGA) and Differential Scanning Calorimety (DSC).

A DuPont 990 Thermal Analysis System was used for this study. The Thermal Gravimetric Analysis was conducted on the FBC particulates first. In this mode of operation, the 990 model is accurate to ±0.25% weight change and ±0.5°C. When the thermograms were assessed and very little sample activity was recorded, it was decided the DSC conducted below 800°C would not produce any meaningful data. The DSC can determine reaction temperatures and phase changes. However, these characteristics usually have been noted as weight gains or losses in the TGA.

The TGA results are reported in Table 3-1. These data indicate that the emitted particulates and overflow bed materials are predominantly inorganic. Figure 3-6 is shown as an example of a TGA. It is the analytical run on sample S-2-3.

With samples that are identified as relatively inactive by the TGA/DSC and uniform in appearance by the PLM, the necessary information, which allows for an updating of the potential compound list, has not been derived. This is the case with regard to the FBC run #2 particulates. However, a stable drying temperature of 150°C was established for all samples.

3.1.3 Specific Anion/Cation Tests

Two techniques were chosen for quantitation of the MATE triggered cations. These were flame and flameless atomic absorption spectroscopy (AAS) and induction coupled plasma optical emission spectroscopy (ICPOES).

3.1.3.1 Sample Preparation

Weighted particulate samples were transferred to Parr Teflon Digestion bombs and digested overnight at 130°C with 5 millimeters of aqua regia. The resultant solutions were filtered through Whatman #41 filter paper. The collected residue was ignited in platinum labware, fused with 1 gram of high purity sodium carbonate Na_2CO_3, dissolved, combined with the original filtrate and then diluted to 50 milliliters.

Table 3-1. Tabulation of Thermal Gravimetric Data

Sample Number	Sample Description	Temperature of Activity (°C)	Precentage Weight Loss (% w/w)
S-2-1	Illinois Coal No. 6	100	4.0
		150	7.0
		200	9.0
		300	9.0
		350	Onset of Organic Fraction Decomposition
S-2-2	Grove Limestone	100	0
		150	0
		> 200	0
S-2-3	Overflow Bed Material >325 Mesh	100	0
		150	0
		200	0
		300	0
		350	0
		400	Onset of Organic Fraction Decomposition
S-2-4	Overflow Bed Material - 325 Mesh	100	2.0
		150	2.2
		200	2.2
		300	2.2
		350	2.2
		400	Onset of Organic Fraction Decomposition
S-2-5	Sludge	100	4.5
		150	4.5
		200	4.5
		300	4.5
		350	4.5
		400	Onset of Organic Fraction Decomposition

Table 3-1. Tabulation of Thermal Gravimetric Data (Continued)

Sample Number	Sample Description	Temperature of Activity (°C)	Precentage Weight Loss (% w/w)
S-2-6	Particulates > 27 μ	100	0
		150	0
		200	0
		300	0
		350	0
		400	Onset of Organic Fraction Decomposition
S-2-7	Particulates < 27 μ	100	1.0
		150	1.0
		200	1.0
		300	1.0
		350	1.0
		400	Onset of Organic Fraction Decomposition

Leachate samples were prepared through 24-hour refluxing extractions in an acidic solution of hydrochloric acid at pH 4 and a basic solution of ammonium hydroxide at a pH 9. Undissolved particulates were removed by filtration and they were not recovered for further analyses because only the leachable materials were of interest in this portion of the study.

Table 3-2 lists the sample codes used throughout this segment of the Level 2 tests.

3.1.3.2 Atomic Absorption Spectroscopy (AAS)

The instrument employed for this analytical effort was a Jarrell-Ash 810 equipped with a FLA-10 Graphite Tube Furnace. The procedures employed and discussed here were chosen to meet an accuracy requirement of ±15% for this technique.

All the procedures were evaluated for matrix effects and accuracy. Evaluations included: (1) comparison of calibration slopes from each sample type with the slope generated from a deionized water standard, (2) recovery

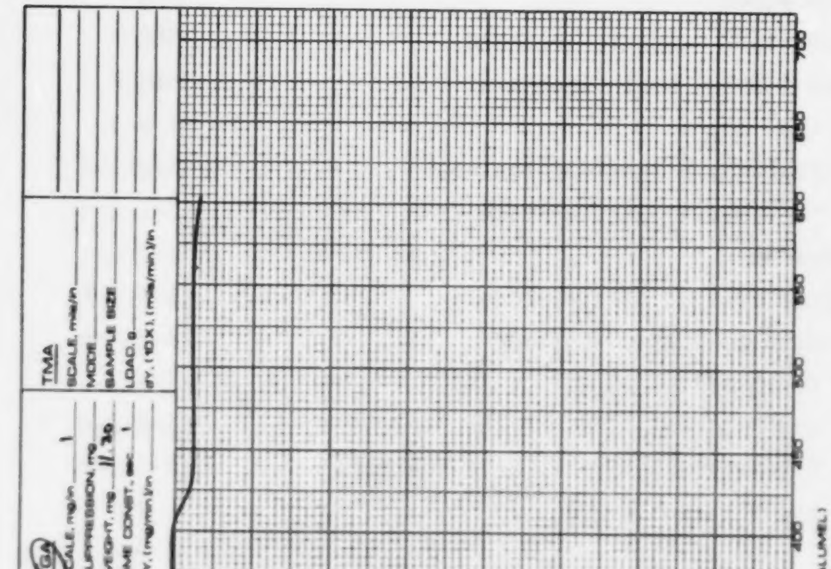


Figure 3-6. Representative TGA Scan, Sample S-2-3

Table 3-2. Sample Codes Used for Quantitative Cation Studies

Sample Identification	Sample Code Number
NBS Flyash #1663	NBS
NBS Flyash #1663 — acidic leachate	NBS-A
NBS Flyash #1663 — basic leachate	NBS-B
Illinois Coal No. 6	S-2-1
Illinois Coal No. 6 — acidic leachate	S-2-1-A
Illinois Coal No. 6 — basic leachate	S-2-1-B
Grove Limestone	S-2-2
Grove Limestone — acidic leachate	S-2-2-A
Grove Limestone — basic leachate	S-2-2-B
Overflow Bed Material >325	S-2-3
Overflow Bed Material >325 — acidic leachate	S-2-3-A
Overflow Bed Material >325 — basic leachate	S-2-3-B
Overflow Bed Material — 325	S-2-4
Sludge	S-2-5
Particulates >27μ	S-2-6
Particulates >27μ — acidic leachate	S-2-6-A
Particulates >27μ — basic leachate	S-2-6-B
Particulates >27μ	S-2-7

of spiked elements in the sample matrix, and (3) comparison of analytical results of NBS 1633 flyash standard (digested particulate samples only). The continuity of the calibration data was also evaluated from correlation coefficients generated for each curve. The elements determined for each sample included: Hg, Li, Sr, Pb, Cu, Ag, Zn, Mg, Ni, Cd, Be, Cr, Pt, V and Si.

Prior experience (3,4,5) has indicated that, even when utilizing the best possible techniques, the attainment of a ±15% accuracy is difficult. In the analysis of the FBC particulates the ability to acquire this accuracy goal was complicated by the limited quantity of sample available.

Calibration curves were generated for each element in each general matrix type, i.e., acidic leachates, basic leachates and dissolved particulates. These curves were prepared using standard additions to each of the respective blank solutions associated with each of the above matrix types. The calibration curves are contained in Appendix A. These curves were then compared to curves generated with deionized water to assess the presence or absence of general matrix interferences. Recovery experiments were also performed for each element in each matrix by spiking an actual leachate or particulate sample. This was done to assure the absence of interferences from unknown dissolved species. Atomic absorption techniques and parameters were chosen so as to obtain the optimum in accuracy and sensitivity using a minimum of solution. These operating parameters are listed in Table 3-3. The graphite furnace and background correction mode were employed whenever possible. The graphite furnace technique is the most sensitive method available and the correction eliminates nonanalyte absorbance (6). The most sensitive analytical lines and optimum instrumental settings were also used (7-11). Quantitative analytical results are reported in Tables 3-4 and 3-5. These values are reagent blank corrected. Discussions on each elemental determination follow. Table 3-6 reports the recovery percentages for spiked sample.

LITHIUM

Lithium was determined by flame emission. The sensitivity by this technique (0.005 μg/ml) is very close to the graphite furnace. The calibration curve is A-1 in Appendix A.

SILVER

Silver was determined as an internal standard for assessment of the cleanliness of sample preparation techniques. The Graphite Furnace was employed. Only one calibration (Curve A-2, Appendix A) was performed using deionized water; spiked leachate blanks gave results within ±10% of the developed calibration. Leachate samples S-2-2-B and S-2-6-A were spiked with 0.02 μg/ml of silver and showed recoveries of 80%. The low recovery in the actual leachate samples is most likely due to substances extracted from the samples either complexing the silver or suppressing its atomization in the graphite furnace. Since most of the leachate samples were very close to the detection limit of 0.0005 μg/ml, this 80% recovery shows that this detection limit may be applied to the leachate samples.

Table 3-3. Atomic Absorption Analytical Operating Parameters

Element	Analytical Wavelength, Å	Background Wavelength, Å	Slit Width, Å	Atomization Source	Analytical Procedure
Ag	3281	3235 (Ne)	10	G.F.*	Dry – 30 sec. @ 200°C Ash – 60 sec. @ 400°C Atomize – 7 sec. @ 2300°C – Argon Gas
Cu	3247	None	10	G.F.*	Dry – 30 sec. @ 200°C Ash – 60 sec. @ 600°C Atomize – 6 sec. @ 2500° C – Argon Gas
Ni	2320	2316	4	G.F.*	Dry – 20 sec. @ 200°C Ash – 30 sec. @ 800°C Atomize – 6 sec. @ 2800°C – Argon Gas
Li	6708	None	2	Air-C_2H_2	Atomic Emission
Mg	2852	None	4	Air-C_2H_2	Atomic Absorption
Pb	2833	2825	4	G.F.*	Dry – 40 sec. @ 200°C Ash – 40 sec. @ 600°C Atomize – 6 sec. @ 1900°C 10 $\mu\ell$ 1.0% HNO_3 & 0.2% $(NH_4)_6Mo_7O_{24}$ added in furnace
Zn	2139	None	4	Air-C_2H_2	Atomic Absorption
Hg	2536	None	10	Flameless	$SnCl_2$ reduction N_2 Sparge 1 1/min
Cd	2288	None	4	Air-C_2H_2	Atomic Absorption
Be	2349	None	4	N_2O-C_2H_2	Atomic Absorption
Cr	3579	None	4	Air-C_2H_2	Atomic Absorption
Pt	2659	Continuum	4	G.F.*	Dry – 30 sec. @ 300°C Ash – 30 sec. @ 1150°C Atomize – 5 sec. @ 2700°C – Argon Gas
V	3185	3196	2	G.F.*	Dry – 30 sec. @ 200°C Ash – 40 sec. @ 1000°C Atomize – 5 sec. @ 2800°C – Argon Gas
Si	2516	None	2	N_2O-C_2H_2	Atomic Absorption
Sr	4607	None	2	Air-C_2H_2	Atomic Emission

---

*Graphite furnace.

Table 3-4. Atomic Absorption Particulate Analysis (μg/g) Results

		Elements											
Sample #	Weight (g)	Li	Ag[1]	Cr	Mg	Hg	Zn	Cd	Be	Pb	V	Si	Sr
S-2-3	0.0623	13	12	76	5,950	<0.8	N.D.	8.0	N.D.	52	48	<4,020	1092
S-2-4	0.0638	26	N.D.	204	10,552	N.D.	N.D.	15.7	N.D.	314	180	4,700	N.D.
S-2-5	0.0677	72	N.D.	316	5,365	441	N.D.	<4	N.D.	<4	370	111,000	N.D.
S-2-6	0.0957	31	21	418	3,456	12	360	<3	<5	167	104	679,000	762
S-2-7-2	0.0163	74	N.D.	756	7,779	176	N.D.	31	N.D.	1,194	491	178,000	N.D.
S-2-7-3	0.0138	76	N.D.	538	6,884	87	N.D.	<18	N.D.	58	580	138,000	N.D.

[1] Blank value higher than samples. Values reported not corrected for any blank.

N.D. — not determined. Based on MATE values these elements were not required in the Level 2 effort.

Table 3-5. Atomic Absorption Leachate Solution Analysis (mg/l) Result

Solution	Elements											
Acidic	Zn	Ag	Li	V	Pb	Cu	Ni	Hg	Be	Pt	Si	Sr
NBS-A	N.D. < 0.005	N.D. <0.0005	0.095	0.08	N.D. <0.02	N.D. <0.01	N.D. <0.01	0.0003	N.D. <0.01	N.D. <0.05	75	0.70
S-2-1-A	N.D. < 0.005	0.0014	0.007	0.14	0.24	N.D. <0.01	0.03	N.D. <0.0002	N.D. <0.01	N.D. <0.05	74	N.D. <0.02
S-2-2-A	0.020	N.D. <0.0005	N.D. <0.002	0.05	0.05	N.D. <0.01	N.D. <0.01	0.0002	N.D. <0.01	0.15	34	N.D. <0.02
S-2-3-A	0.22	0.0041	0.035	N.D. <0.02	0.22	N.D. <0.01	N.D. <0.01	N.D. <0.0002	N.D. <0.01	N.D. <0.05	260	1.67
S-2-6-A	N.D. <0.005	N.D. <0.0005	0.043	0.05	0.10	N.D. <0.01	N.D. <0.01	N.D. <0.0002	0.02	N.D. <0.05	300	0.28
Basic												
NBS-B	0.046	N.D. <0.0005	0.092	N.D. <0.02	N.D. <0.02	N.D. <0.01	N.D. <0.01	N.D. <0.0002	N.D. <0.01	N.D. <0.05	71	0.40
S-2-1-B	0.071	0.0005	0.005	0.08	0.49	N.D. <0.01	0.04	N.D. <0.0002	N.D. <0.01	N.D. <0.05	12	0.60
S-2-2-B	N.D. <0.005	0.0009	0.006	N.D. <0.02	N.D. <0.02	N.D. <0.01	N.D. <0.01	N.D. <0.0002	N.D. <0.01	N.D. <0.05	144	N.D. <0.02
S-2-3-B	N.D. <0.005	N.D. <0.0005	0.023	N.D. <0.02	0.010	N.D. <0.01	N.D. <0.01	N.D. <0.0002	N.D. <0.01	N.D. <0.05	N.D. <5	2.19
S-2-6-B	N.D. <0.005	N.D. <0.0005	0.026	N.D. <0.02	N.D. <0.002	N.D. <0.01	N.D. <0.01	N.D. <0.0002	--	N.D. <0.05	N.D. <5	0.55

N.D. Not Detected.

Table 3-6. Percent Recovery of Spiked Samples by Atomic Absorption

	Solutions		
	Leachates		
Element	Acid	Basic	Particulate
Zn	104	105	-
Mg	-	-	95
Ag	80	80	78
Ni	60	110	-
Li	104	103	-
Cu	80	80	-
Cd	-	-	110
Be	100	100	100
Cr	-	-	84
Pb	105, 97	93	130, 84
Pt	100	64	-
V	113	107	116
Si	96	122	107
Hg	100	100	102
Sr	75	80	106

The particulate samples were more of a problem as the reagent blank contained a background contamination of almost 0.025 µg/ml silver. This contamination is known to have been introduced into the samples during the ashing phase in the muffle furnace and was therefore, used as an internal standard for assessment of the sample preparation techniques.

A 90% recovery was obtained from a spiked reagent blank from this series. A detection limit of 0.05 ppm was assigned to the particulate samples and is due to the high background experienced.

CHROMIUM

Chromium was determined by flame atomic absorption on the particulate samples only, so only two calibration curves were generated, A-3, Appendix A.

As is represented by the slopes, the two calibrations are linear and lie almost directly atop each other. The recovery of 80% of the spiked chromium is low but within the necessary tolerance range, however, it may have been possible to better this recovery and increase sensitivity using the graphite furnace.

MAGNESIUM

Magnesium was determined on the particulate samples only by utilizing the atomic absorption flame technique. This was the selected method of analysis as the reagent blank contained approximately 1000 times the sensitivity check for the graphite furnace atomization technique. All of the samples proved to be outside the linear range of the primary wavelength, making dilution of between one-in-ten and one-in-forty necessary. Since the samples required this great a dilution, little background problems due to the solution matrices were anticipated. The spike recovery on the diluted blank and particulate samples of 95% and 105% bore out this opinion. The values were, therefore, determined using the linear graph constructed with standards of 0, 0.1, 0.25, 0.5 and 1.0 μg/ml magnesium in distilled water, calibration curve A-4, Appendix A.

MERCURY

Mercury was determined using a "cold vapor AA" procedure which entails the reduction of ionic mercury by $SnCl_2$ in acid solution to its elemental form. This is followed sequentially with sparging of the solution with nitrogen and passage of the gas stream through a UV cell where the mercury resonant wavelength at 253.6 mm is monitored. Experience on EPA contracts No. 68-02-2165 and 68-02-2197 in this laboratory has shown that the procedure is applicable to a wide variety of matrices, hence only one calibration with deionized water was performed. Spikes of the leachate and particulate samples yielded recoveries of 100% for both leachates and 102% for particulate sample S-2-6. Calibration curve A-5, Appendix A, was used to generate this data set.

ZINC

The flame atomic absorption technique was employed for the zinc determination due to reported source contamination in using the graphite furnace as an atomization source. A calibration curve using deionized water and 1% HCl was generated, A-6 Appendix A. Due to limited sample size, rapid reduction of the sample was a problem. Therefore, only the deionized water calibration curve was capable of being generated. The recovery of 105% of the basic spike of sample S-2-2-B and 104% of the acidic spike of sample S-2-2-A would show that the use of the deionized water and 1% HCl calibration curve would be proper for reporting values in the two background matrices. The single particulate sample determination necessitated a one-in-ten dilution to bring it into working range and, therefore, matrix background was not considered a problem.

CADMIUM

Cadmium was determined on the particulate samples only and the flame atomic absorption technique was utilized. Calibration curves were developed with the deionized H_2O, HCl, and particulate reagent blank background matrices, A-7, Appendix A. They were identical in slope and correlation coefficient.

The sensitivity of cadmium utilizing the graphite furnace technique is reported as being a factor of two better, and its use should be considered in subsequent analysis.

BERYLLIUM

Beryllium was determined utilizing the flame atomic absorption technique. Calibration curves were plotted using deionized H_2O and 1% HCl, acidic leachate blank, basic leachate blanks, and particulate reagent blank, A-8, Appendix A.

LEAD

In the first attempt at determining Pb, utilizing the graphite furnace as the atomization source, the "neat" solutions were injected into the apparatus. The calibration curves produced by this method proved to be unsatisfactory and the spiked leachate samples showed a recovery of less than

30%. With these results generated, it was necessary to obtain more information on the determination of Pb by this atomization technique. In the November 1977 issue of American Laboratory, an article suggested that solutions for the analysis of lead contain 0.5% HNO_3 (w/v) and 0.1% $(NH_4)_6Mo_7O_{24}$ (w/v); because the FBC samples were too small in volume to use sufficient sample to produce these dilutions, an addition was made directly into the graphite furnace. A solution containing 1.0% HNO_3 (w/v) and 0.2% $(NH_4)_6Mo_7O_{24}$ (w/v) was injected into the graphite furnace in 10 µℓ increments, followed by 10 µℓ of sample or standard solution. The calibration curves, A-9, Appendix A, were then acceptable. The particulate reagent blank calibration yielded a substantially depressed slope even with the addition of $(NH_4)_6Mo_7O_{24}$. Recoveries of spikes from leachate samples were excellent and those from the particulate sample marginally acceptable.

VANADIUM

Vanadium was determined utilizing the graphite furnace for atomization. Four calibration curves, A-10, Appendix A, were generated using 2% HNO_3 in deionized H_2O, basic and acidic leachate blanks, and the particulate reagent blank. The recovery of spikes in the actual acidic, basic, and particulate samples were: 113%, 107%, and 116%, respectively, and the correlation coefficient of all calibration curves was 0.99%. These were quite acceptable to the Level 2 requirements.

SILICON

Silicon was determined by atomic absorption. Use of the graphite furnace as an atomization source was attempted, however, levels of silicon in all the groups of samples were well-above the effective range of this method. Massive dilutions would have been necessary to bring the samples into the linear range of the graphite furnace method. Therefore, it would be inappropriate for this analysis.

Calibration curves were generated for each of the four different background matrices, A-11, Appendix A.

The calibration curves lie in close proximity and have good correlation coefficients.

Spiked samples show a recovery of 122% in the basic leachate sample, 96% in the acid leachate sample, and 107% in the particulate sample. The high recovery in the basic leachate was rechecked and confirmed. The reason for the high recovery in the basic leachate would necessitate further experimentation as the interference appears to be caused by something other than simply the background matrix.

STRONTIUM

Strontium was determined using flame atomic emission. Due to the small quantity of sample available and the need for relatively long aspiration times only deionized water matrix calibration curves were developed. The calibration curves were set up in two ranges — 0.0 to 1.0 and 0 to 10 rather than diluting the samples to meet the requirements of one range, A-12 and and A-13, Appendix A.

Although separate calibration curves were not developed, spiked samples were utilized to assess the accuracy effects for each group. The recovery in the spiked samples were 80% in the acidic, 75% in the basic, and 106% in the particulate. Further experimentation using the graphite furnace and more complete research into the problems of background matrices should be explored for this element.

COPPER

The graphite furnace was utilized as the atomization source for the copper determination. The samples, standards, and leachate standards were injected, "neat," into the furnace cavity and this was found to give satisfactory results.

The calibration curves generated, A-14, Appendix A, showed an excellent correlation between the array of slopes. A recovery of only 80% of the spiked copper in both the acidic and basic leachate samples was somewhat disappointing as was the sensitivity check of 0.165 μg/mℓ for 0.2 absorbance reading.

NICKEL

Nickel was determined utilizing the graphic furnace as an atomization source. Three calibration curves were produced using the deionized water with HNO_3, basic leachate blank, and acidic leachate blank as background matrices, A-15, Appendix A.

Although the slopes varied as much as 0.38, the three calibration curves showed good linearity and correlation coefficients. This type of comparison between calibration curves shows the need for methods which will take the problem of matrix background on a case-by-case basis.

Particulate sample values were determined from the acidic leachate calibration curve, as the particulate reagent blank showed a nickel level of 0.26 ppm. This high nickel value was most likely due to contamination from the muffle furnace used in the sample preparation.

PLATINUM

Platinum was determined utilizing the graphite furnace as the atomization source. The samples, blanks, and standards were injected, "neat," into the furnace cavity and the calibration curves generated, A-16, Appendix A, showed good correlation between the three background matrices. Recovery of spiked samples was 100% inthe acidic leachate and a rather poor (64%) in the basic leachate. Low recovery of the basic leachate sample spike might have been due simply to the basic nature of the background matrix, however, this is not the case in the basic blank standard addition. These two observations point to the probability of an interference produced in the actual leaching process.

Particulate samples were checked for platinum content as the fusion was performed in platinum crucibles; as a result, all samples showed platinum present.

3.1.3.3 Induction Coupled Plasma Optical Emission Spectroscopy (ICPOES)

ICPOES analyses were conducted using an Applied Research Laboratories (ARL) prototype instrument, Model QA-137, on all the leachate solutions. In this instrumental technique, liquid samples are aspirated into a high temperature argon plasma produced by inductively coupling radio-frequency electromagnetic radiation to the argon gas (12). The high temperature of the plasma ($\sim 10{,}000^{\circ}K$) causes dissociation, molecular breakdown, atomization, and/or ionization and excitation of the metals in solution. The resultant radiation produced as the excited atoms relax is passed through the entrance slit of a dispersive device where it is separated into discrete wavelengths. In this multielement technique, the intensity of each of the characteristic wavelengths is associated with a metallic element and is measured by a photomultiplier tube. The photocurrent is transformed, by reference standards, to concentration values. In general the detection limits are on the order of 0.01 μg/mℓ, although they vary from element to element and from matrix to matrix.

Standard additions of Al, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K and Ba were made to each leachate to assess matrix effects and recovery. Calibration of the instrument was accomplished using reagent salts diluted with deionized water. Some precipitation was observed (thought to be $Fe(OH)_3$ based on its reddish-brown color) in the spiked solutions: S-2-1-B, S-2-3-B, and S-2-6-B. This effects the recovery of not only the spiked Fe but also other elements capable of coprecipitation or occlusion in these solutions. Accuracy of recovery in ICPOES is effected by:

- Viscosity — affects flow rate of solution and nebulization efficiency.
- Shifts in the emission maximum in the plasma, thus, not all elements are equally excited.

Table 3-7 lists the mg/ℓ values obtained for each element scanned in each leachate.

Table 3-8 reports the average percent recovery. This is based on 11 standard additions of the following elements in each matrix: Fe, K, Mg, Mn, Al, Ba, Ca, Cu, Cd, Cr, Co, Pb. In general the average recovery of 96.1% in the acidic leachates and 96.7% in the basic leachates are excellent and within the technique requirements of ±15%.

These quantitative cation values generated from the AAS and the ICPOES efforts will be used subsequently to derive the compound concentrations when a single compound has been identified. For example, if Fe_2O_3 is the only iron compound identified, then its quantitative value in the particulates will be based on the Fe content established by AAS. In future Level 2 efforts the compound identification techniques used in Section 3.2 can be optimized to provide semiquantitative conformation. However, this

Table 3-7. ICPOES Results on Leachate Samples

	Sample Code	Element (mg/ℓ)																				
		Fe	K	Mg	Mn	Na	P	Se	Al	B	Ba	Be	Ca	Cu	Ag	As	Cd	Co	Cr	Mo	Ni	Zr
Acidic Leachates	S-2-1-A	45.97	0.8	2.06	0.16	N.D.	N.D.	N.D.	1.11	2.9	N.D.	N.D.	20.0	0.007	N.D.	N.D.	N.D.	N.D.	0.009	N.D.	N.D.	N.D.
	S-2-2A	0.082	0.7	0.547	N.D.	N.D.	N.D.	N.D.	0.64	1.5	0.46	N.D.	10.04	0.004	N.D.	0.2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
	S-2-3-A	0.002	4.5	1.36	N.D.	N.D.	N.D.	N.D.	7.14	20.3	N.D.	N.D.	985.0	0.012	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
	S-2-6-A	0.197	12.3	1.32	0.59	1.0	N.D.	N.D.	15.1	15.76	N.D.	N.D.	277.0	0.014	N.D.	0.3	N.D.	N.D.	0.018	N.D.	N.D.	0.007
Basic Leachates	S-2-1-B	58.3	2.2	0.72	0.10	75.0	N.D.	N.D.	0.94	1.90	N.D.	N.D.	6.86	0.019	0.012	N.D.	N.D.	0.12	0.014	0.20	N.D.	N.D.
	S-2-2-B	N.D.	4.0	0.08	N.D.	14.0	N.D.	N.D.	0.26	6.49	N.D.	N.D.	15.76	0.01	0.013	N.D.	N.D.	0.11	0.007	0.44	N.D.	0.016
	S-2-3-B	N.D.	2.7	N.D.	N.D.	17.0	N.D.	N.D.	0.21	10.5	N.D.	N.D.	266.0	0.002	N.D.	N.D.	N.D.	N.D.	N.D.	0.06	0.17	N.D.
	S-2-6-B	22.9	9.9	4.28	0.003	125.0	N.D.	N.D.	2.4	9.9	N.D.	N.D.	34.0	0.002	N.D.	N.D.	N.D.	N.D.	N.D.	0.17	N.D.	N.D.

N.D. Not Detected

Table 2-8. ICPOES Recovery Results

	Fe	K	Mg	Mn	Al	B	Ba	Ca	Cu	Cd	Co	Cr	Mo	Ni	Average Recovery
Acidic Leachates	94.05	98.4	94.0	93.0	94.9	100.3	103.0	96.5	94.5	91.1	96.6	97.7	94.5	97.2	96.1
Basic Leachates	74.1*	102.0	95.2	94.3	95.1	94.0	112.0	104.3	97.4	96.7	96.3	92.7	94.2	105.1	96.7

*$Fe(OH)_3$ was observed as a precipitate.

study is the first conducted and quantitation was not yet feasible with many of these developmental techniques. The time expended to generate reasonably accurate cation data was, therefore, very necessary to this analysis.

3.1.3.4 Anion Quantitation

Unfortunately, sufficient quantities of sample were not available for specific anion studies. It was felt that sufficient, as well as additional, information would be obtained from alternate techniques which require less sample, e.g., FTIR using only 50 mg.

Without sufficient sample for cation quantitation the inorganic Level 2 analysis proceeded onto phase two, the Study of Bulk Chemical Composition.

3.2 BULK COMPOSITION CHARACTERIZATION (Refer to Figure 3-7)

In this segment of the analysis three techniques, Fourier Transform Infrared Spectroscopy (FTIR), Electron Spectroscopy for Chemical Analysis (ESCA), and X-Ray Powder Diffraction (XRD), were used to identify compounds present and oxidation states.

3.2.1 FTIR

The instrument employed in this study was a Nicolet Series 7000, Fourier Transform Infrared System. This system has excellent compound sensitivity and wavelength accuracy to 0.06 cm^{-1}. Its computer capabilities provide for background correction and spectral enhancement.

3.2.1.1 Sample Preparation

Based on the prior TGA data, drying was not necessary to produce acceptable FTIR spectra on the FBC particulate samples. Therefore, the sample required only mulling with mineral oil (Nujol) and deposition on AgCl or polyethylene infrared windows. The samples analyzed by this technique were the emitted particulates (S-2-6 and S-2-7), the sludge (S-2-5), and the overflow bed materials (S-2-3 and S-2-4). The feed materials were not submitted for analysis. Aqua regia extraction and subtraction of insolubles was not possible due to sample quantities.

Spectra were taken in both the far IR (400-50 cm^{-1}) and the mid IR regions (1400-400 cm^{-1}). The far IR measurements were characterized as consistently uninterpretable. This was due to the low energy throughput and the high scattering of these particulate samples. Background subtraction

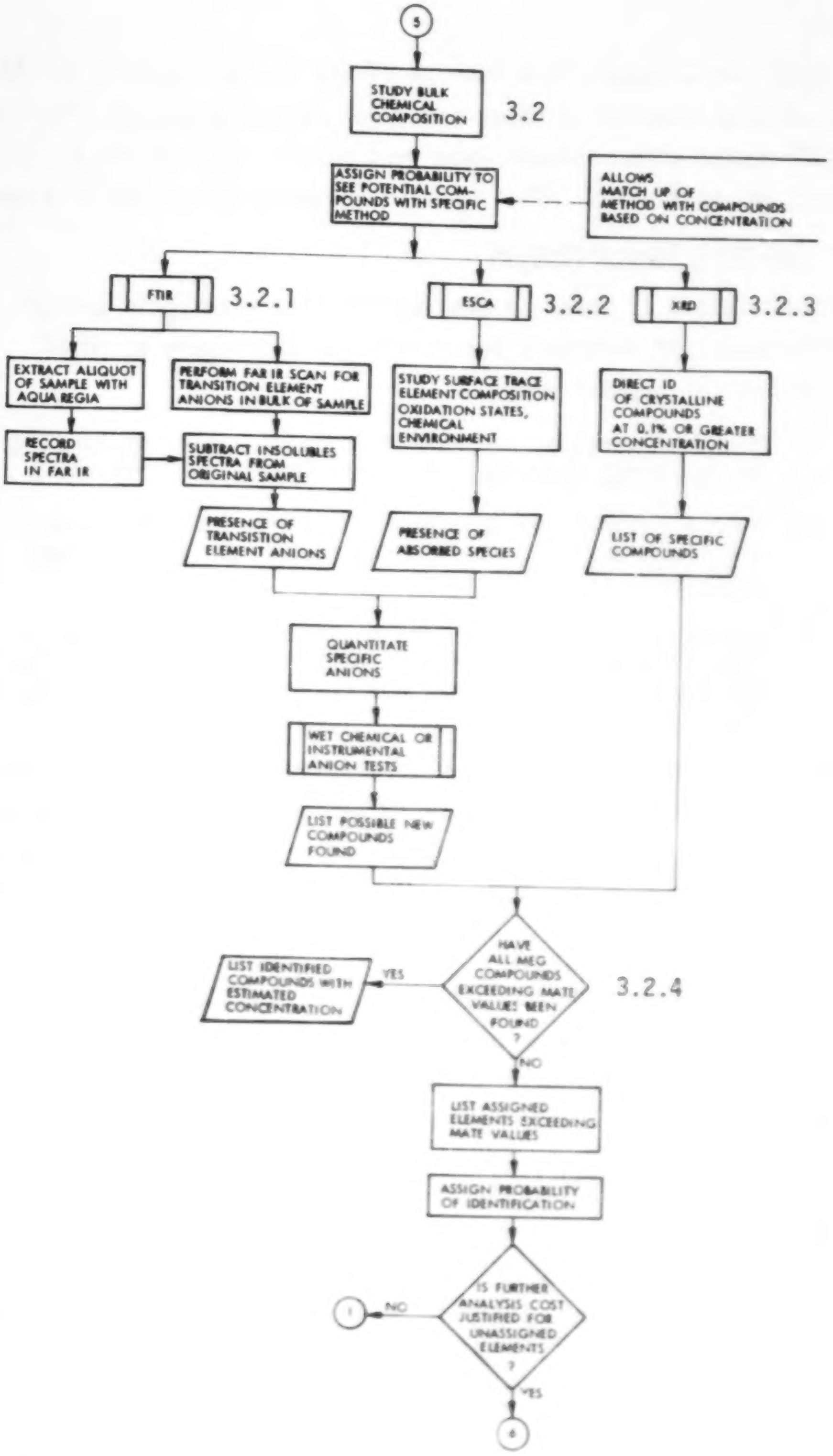

5
STUDY BULK CHEMICAL COMPOSITION
3.2
ASSIGN PROBABILITY TO SEE POTENTIAL COMPOUNDS WITH SPECIFIC METHOD
ALLOWS MATCH UP OF METHOD WITH COMPOUNDS BASED ON CONCENTRATION
FTIR
3.2.1
ESCA
3.2.2
XRD
3.2.3
EXTRACT ALIQUOT OF SAMPLE WITH AQUA REGIA
PERFORM FAR IR SCAN FOR TRANSITION ELEMENT ANIONS IN BULK OF SAMPLE
STUDY SURFACE TRACE ELEMENT COMPOSITION OXIDATION STATES, CHEMICAL ENVIRONMENT
DIRECT ID OF CRYSTALLINE COMPOUNDS AT 0.1% OR GREATER CONCENTRATION
RECORD SPECTRA IN FAR IR
SUBTRACT INSOLUBLES SPECTRA FROM ORIGINAL SAMPLE
PRESENCE OF TRANSISTION ELEMENT ANIONS
PRESENCE OF ABSORBED SPECIES
LIST OF SPECIFIC COMPOUNDS
QUANTITATE SPECIFIC ANIONS
WET CHEMICAL OR INSTRUMENTAL ANION TESTS
LIST POSSIBLE NEW COMPOUNDS FOUND
HAVE ALL MEG COMPOUNDS EXCEEDING MATE VALUES BEEN FOUND ?
3.2.4
YES
LIST IDENTIFIED COMPOUNDS WITH ESTIMATED CONCENTRATION
NO
LIST ASSIGNED ELEMENTS EXCEEDING MATE VALUES
ASSIGN PROBABILITY OF IDENTIFICATION
IS FURTHER ANALYSIS COST JUSTIFIED FOR UNASSIGNED ELEMENTS ?
NO
1
YES
6

Figure 3-7. Logic Flow for Bulk Composition Characterization

of the Nujol was attempted but because of the nonreproducible scattering effects spectral absorption bands could not be characterized with confidence. The mid IR region work produced excellent quality spectra and the Nujol background was subtracted. The spectra have been reproduced in Appendix B.

3.2.1.2 Spectral Interpretation

Interpretation is based on peak correlation with known spectra. Three major references for inorganic interpretation which were especially useful in this analytical segment were:

1) Richard A Nyquist and Ronald O. Kagel, Infrared Spectra of Inorganic Compounds, Academic Press, New York, 1971.

2) Foil A. Miller and Charles H. Wilkins, Infrared Spectra and Characteristic Frequencies of Inorganic Ions, Anal. Chem., Vol 24, 1253, 1952.

3) Leonard C. Afremow and John T. Vanderberg, High Resolution Spectra of Inorganic Pigments and Extenders In the Mid-Infrared Region from 1500 cm^{-1} to 200 cm^{-1}, Beckman Reprint R-6236.

Table 3-9 reports the compounds identified from spectral correlation. In the far IR only the spectrum obtained for S-2-6 was interpretable. In summary, the compounds identified by this technique were $CaSO_4$ (anhydrous and in two hydrated forms), $CaCO_3$ (two crystalline forms), SiO_2 and Fe_2O_3.

3.2.2 ESCA

Electron spectroscopy for chemical analysis (ESCA) was conducted on the sludge sample (S-2-5), the particulates >27μ (S-2-6), and the particulates <27μ (S-2-7). The instrument employed was Physical Electronic Industries, Model 540A.

3.2.2.1 Sample Preparation

Sample preparation followed that outlined in the reference text using the "sticky gold" technique. This mounting approach (shown in Figure 3-8) overcomes the conductivity problem and provides a secure mount for the samples.

3.2.2.2 ESCA Results

Appendix C contains the ESCA scans. Surface analysis was conducted on all samples analyzed and Argon etching was employed to detect interior

Table 3-9. Infrared Spectral Interpretation

Spectral Region	Sample Code	Compound Identified	Absorption Peaks Identified (wavelength, cm-1)	Relative Abundance*
Far Infrared	S-2-6	$CaSO_4 \cdot 1/2\ H_2O$	250 175 120	Major
		Fe_3O_4	410 200	Medium
		$CaSO_4 \cdot 2H_2O$	320	Medium
Mid Infrared	S-2-3	$CaSO_4 \cdot 2H_2O$ and $CaSO_4$ (anhydrous)	1100-1190 725 670 610	Major
		$CaCO_3$ (vaterite)	1400 875 (side peak 850) 740 710	Medium
	S-2-4	$CaCO_3$ (calcite)	1400 875 715	Medium
		$CaSO_4 \cdot 2H_2O$ and $CaSO_4$ (anhydrous)	1100-1190 725 670 610 595	Medium
		SiO_2 (crystalline)	800 780	Low
	S-2-5	SiO_2 (crystalline)	1050 (broad) 800 780 695 460	Major
	S-2-6	$CaSO_4 \cdot 2H_2O$ and $CaSO_4$ (anhydrous)	1100-1190 725 670 610 595	Medium
		SiO_2	800 780 460	Low
		Fe_2O_3	410	Low
	S-2-7-2 and S-2-7-3	SiO_2	1100 (broad) 800 780 460	Medium
		$CaSO_4 \cdot 2H_2O$ and $CaSO_4$ (anhydrous)	1100-1190 725 670 610 595	

*	Major	> 10%
	Medium	5-10%
	Low	1-5%
	Trace	< 1%

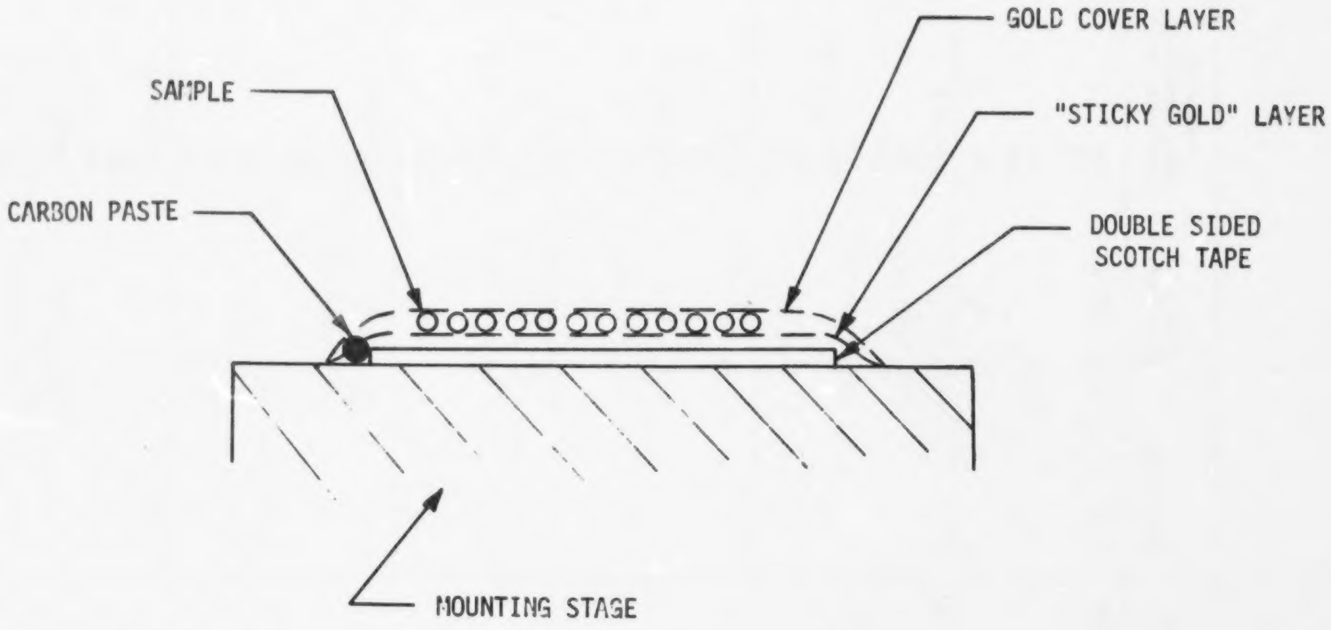

GOLD COVER LAYER
SAMPLE
"STICKY GOLD" LAYER
CARBON PASTE
DOUBLE SIDED SCOTCH TAPE
MOUNTING STAGE

Figure 3-8. Mounting of ESCA Samples Using "Sticky Gold" Technique

variations and obtain elemental profiles on some. Table 3-10 summarizes the data generated. The most interesting information derived from this phase of the analysis was that the particulates <27µ contained $SO_4^=$ on the surface and a mixture of $SO_4^=$ and $S^=$ in the interior. The average ratio of $SO_4^=$ to S^- in this sample is approximately 5.5 $SO_4^=$ to 4.5 $S^=$. Correlation with the infrared data would indicate that Ca is present as $CaSO_4$ and CaS and that the other inorganic elements are present as oxides, i.e., Fe_2O_3, Al_2O_3, Na_2O, and SiO_2.

3.2.3 XRD

X-ray powder diffraction, a direct inorganic compound identification technique, was applied to 100 mg samples of the overflow bed materials (S-2-3, S-2-4), the sludge (S-2-5), the particulates >27µ (S-2-6), and the particulates <27µ (S-2-7). Due to the limited sample quantities, an alternative technique to the low angle-high sensitivity one had to be utilized. The technique employed used the General Electric XRD-6 instrument equipped with a powder diffraction camera for long analysis and exposure times. Fast speed film was used at longer than normal exposure to produce acceptable diffraction patterns. Numerous diffraction lines were obtained in all samples. The accuracy of the d-spacings using this technique is ±0.05 -0.1. The major compounds identified are given in Table 3-11.

3.2.3.1 Sample Preparation

All these samples were packed into glass capillary tubes and irradiated using an iron tube for 24 hours.

3.2.3.2 XRD Results

The 2θ angles and d-spacings were calculated and the literature was searched for compound correlation. Many lines remain unassigned. Computer aid was not available to improve the literature search for compound identification.

3.2.4 Summary of MEG Compounds Exceeding MATE Values Identified

Based on this set of data and that generated from that Initial Sample Characterization phase, the following circled compounds, elements or ions have been identified in the total emission samples. This is the potential compound list generated under Section 3.1.1.

Table 3-10. ESCA Results

Sample Code	Sample Area	Elements Identified	Atom Percent	Oxidation States Derived
S-2-5	Surface	Fe_{2p}	3	Fe^3
		O_{1s}	64	O^{-2}
		Ca_{2p}	4	Ca^2
		C_{1s}	-	C
		Na_{1s}	0.2	Na^1
		S_{2p}	1	S^6
		Si_{2s}	18	Si^2
		Al_{2s}	10	Al^3
	Interior 100Å	Fe_{2p}	3	Fe^3
		O_{1s}	54	O^{-2}
		Ca_{2p}	0.6	Ca^2
		C_{1s}	-	C
		Na_{1s}	0.03	Na^1
		S_{2p}	-	S^6
		Si_{2s}	21	Si^2
		Al_{2s}	18	Al^3
S-2-6	Surface	Fe_{2p}	2	Fe^3
		O_{1s}	62	O^{-2}
		Ca_{2p}	4	Ca^2
		C_{1s}	-	C
		S_{2p}	2	S^6
		Si_{2s}	22	Si^2
		Al_{2s}	8	Al^3

Table 3-10. ESCA Results (Continued)

Sample Code	Sample Area	Elements Identified	Atom Percent	Oxidation States Derived
S-2-7	Surface	Fe_{2p}	1	Fe^{3}
		O_{1s}	61	O^{-2}
		Ca_{2p}	5	Ca^{2}
		C_{1s}	-	C
		Na_{1s}	2	Na^{1}
		S_{2p}	7	S^{6}
		Si_{2s}	13	Si^{2}
		Al_{2s}	12	Al^{3}
S-2-7	Interior 100Å	Fe_{2p}	1	Fe^{3}
		O_{1s}^{-2}	53	O^{-2}
		Ca_{2p}	10	Ca^{2}
		C_{1s}	-	C
		Na_{1s}	1	Na^{1}
		S_{2p}	5	$SO_4^{=}$, S^{-} ratio 6:4
		Si_{2s}	16	Si^{2}
		Al_{2s}	15	Al^{3}
	Interior 200Å	Fe_{2p}	2	Fe^{3}
		O_{1s}	53	O^{-2}
		Ca_{2p}	9	Ca^{2}
		C_{1s}	-	C
		Na_{1s}	1	Na^{1}
		S_{2p}	3	$SO_4^{=}$, S^{-} ratio 5.5:4.5
		Si_{2s}	17	Si^{2}
		Al_{2s}	14	Al^{3}

Table 3-11. XRD Results

Sample Code	Determined d-spacings	Compound Identified	Literature d-spacings	Relative Intensity
S-2-5	2.52	Fe_2O_3	2.51	Strong
	3.68		3.66	
	2.69		2.69	
	1.48		1.48	
	1.84		1.84	
	1.69		1.69	
	3.36	SiO_2	3.34	Medium
	4.26		4.26	
	1.82		1.82	
	1.54		1.54	
	2.46		2.46	
	2.26		2.28	
	2.84	$CaSO_4$	2.85	Medium
	2.28		2.33	
	3.06		3.05	
S-2-6	3.37	SiO_2	3.34	Strong
	4.27		4.26	
	1.82		1.82	
	1.54		1.54	
	2.47		2.46	
	2.29		2.28	
	2.52	Fe_2O_3	2.51	Medium
	3.64		3.66	
	2.70		2.69	
	1.49		1.48	
	1.70		1.69	
	2.85	$CaSO_4$	2.85	Medium
	2.30		2.33	
	3.04		3.05	
	2.85	CaS	2.85	Low
	2.09		2.01	
	1.61		1.64	
	2.41	CaO	2.41	Low
	1.74		1.70	
	2.70		2.78	

Table 3-11. XRD Results (Continued)

Sample Code	Determined d-spacings	Compound Identified	Literature d-spacings	Relative Intensity
S-2-7	3.34 4.26 1.82 2.46 2.28	SiO_2	3.34 4.26 1.82 2.46 2.28	Strong
	2.84 3.67 2.69 1.69	$CaSO_4$	2.85 3.66 2.69 1.69	Strong
	2.84 2.03 1.64	CaS	2.85 2.01 1.64	Medium
	2.51 3.67 2.69 1.69	Fe_2O_3	2.51 3.66 2.69 1.69	Low

Compounds, Elements and Ions Identified:

Li, Li^+, Li_2CO_3

Na^+ Na_2O

K^+

Be^{++}, BeO, $BeO \cdot Al_2O_3 \cdot SiO_2$

Mg^{++}, MgO, $MgSO_4$, $MgCO_3$, $MgCO_3 \cdot CaCO_3$

Ca^{++}, $CaCO_3$, $CaSO_4$, $MgCO_3 \cdot CaCO_3$

Sr^{++}, $SrSO_4$

Ba, $BaCO_2$, $BaSO_4$

Al^{+3}, $Al_2O_3 \cdot 3H_2O$, Al_2O_3

Tl

SiO_4^{-2}, SiO_3^{-2}, $\boxed{SiO_2}$, SiC $\boxed{Si}$

$\boxed{Pb^{+2}}$, $\boxed{Pb^{+4}}$, PbO, $PbSO_4$, $PbCO_3$, $Pb_3(PO_4)_2$, $PbCrO_4$

PO_4^{-3} $\boxed{P}$

$\boxed{As^{+3}}$, $\boxed{As^{+5}}$, AsO_4^{-3}, AsO_3^{-3}, As_2O_3

Y + 3

$\boxed{Se^{-2}}$, SeO_3^{-2}, SeO_4^{-2}, SeO_2

Ti^{+3}, Ti^{+4}, TiO_2

$\boxed{Zr^{+4}}$, ZrO_2

$\boxed{V^{+3}}$, VO^{+2}, VO_4^{-4}, VO_3, VO^{+3}, VO, V_2O_3, V_2O_4, V_2O_5, $VOSO_4 \cdot 5H_2O$

$\boxed{Cr^{+2}}$, $\boxed{Cr^{+3}}$, CrO_4^{-2}, $Cr_2O_4^{-2}$, $Cr_2O_7^{-2}$, Cr_2O_3, $FeO\ Cr_2O_3$, $FeCrO_4$

$\boxed{Mn^{+2}}$, $\boxed{Mn^{+3}}$, MnO_4, MnO, MnO_2, $MnCO_3$, $MnSO_4$

$\boxed{Fe^{+2}}$, $\boxed{Fe^{+3}}$, FeO, $FeO \cdot Fe_2O_3$, $\boxed{Fe_2O_3}$, $K\ FeSi_2O_6$

$\boxed{Co^{+2}}$, $\boxed{Co^{+3}}$, $CoCO_3 \cdot 4H_2O$, CoO

Rh^{+3}

$\boxed{Ni^{+2}}$, $\boxed{Ni^{+3}}$, NiO

$\boxed{Pt}$

$\boxed{Cu^{+}}$, $\boxed{Cu^{+2}}$, CuO, Cu_2O, $CuSO_4$, $CuCO_3$

$\boxed{Ag^{+}}$, $AgCl$

$\boxed{Cd^{+2}}$, CdO

$\boxed{Hg^{++}}$, $HgCl$

Further analysis was necessary to confirm and assess how these compounds were present in the relatively uniform samples, e.g., are any hazardous species in the smaller, respirable size range. The remainder of the FBC analysis, therefore, centered on individual particle characterization.

3.3 SINGLE PARTICLE ANALYSIS (Figure 3-9)

This phase of analysis was conducted to verify prior data, assess the uniformity of the emitted particulates, and obtain a reasonable closure to the Level 1 triggered species. The techniques employed consist of: Scanning Electron Microscopy (SEM) with Energy Dispersive Analysis of X-rays (EDX), Electron Beam Microprobe (EPMA), and Transmission Electron Microscopy (TEM) with Selected Area Electron Diffraction (SAED).

3.3.1 SEM-EDX

The overflow bed materials, sludge, and particulates were scanned using the JEOL SEM equipped with the Princeton Gamma Tech EDX unit. In general the samples were uniform in appearance with the EDX giving bulk composition information. Figures 3-10 through 3-14 are representative of the SEM images and their composition by EDX is indicated. The EDX scans are presented in Appendix D. SEM photographs accompany these indicating the exact areas where EDX analysis was performed.

3.3.1.1 Sample Preparation

Samples were mounted on gold sample stages. They were uncoated. The gold stage was found to provide an excellent conducting mount. A clean stage was analyzed to provide any necessary background information.

3.3.1.2 SEM-EDX Results

In general the data correlated excellently with those found in earlier phases of the analyses. The samples are fairly uniform in composition with the major elements present identified as calcium, and silicon with traces of elements such as titanium and potassium. Iron is present in the instrument background and, therefore, cannot be detected above this background.

3.3.2 EPMA

The Electron Beam Microprobe analysis was conducted on the samples mounted and imaged on the SEM. The instrument employed was an Applied

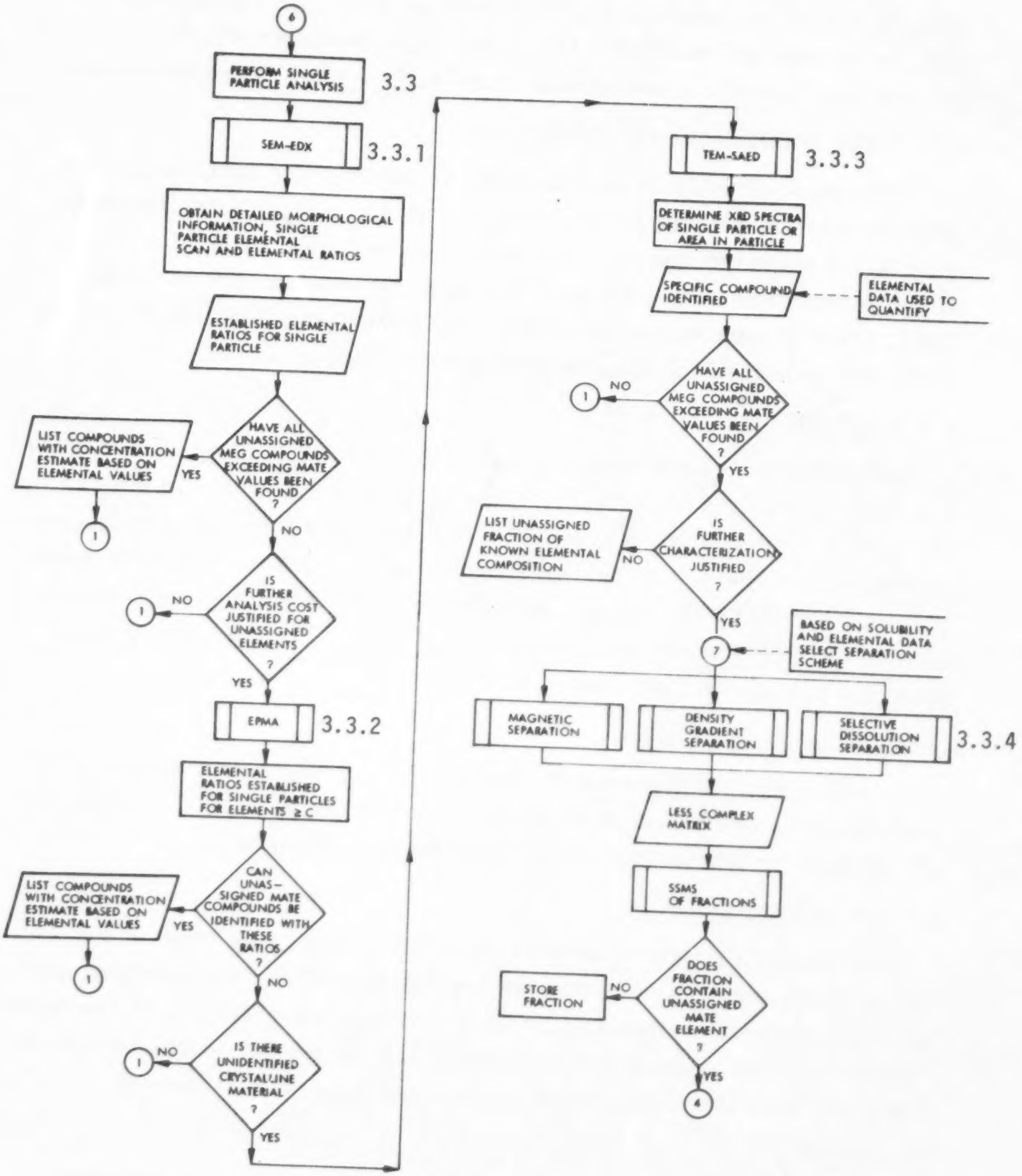

6
PERFORM SINGLE PARTICLE ANALYSIS
3.3
SEM-EDX
3.3.1
OBTAIN DETAILED MORPHOLOGICAL INFORMATION, SINGLE PARTICLE ELEMENTAL SCAN AND ELEMENTAL RATIOS
ESTABLISHED ELEMENTAL RATIOS FOR SINGLE PARTICLE
HAVE ALL UNASSIGNED MEG COMPOUNDS EXCEEDING MATE VALUES BEEN FOUND ?
YES
LIST COMPOUNDS WITH CONCENTRATION ESTIMATE BASED ON ELEMENTAL VALUES
1
NO
IS FURTHER ANALYSIS COST JUSTIFIED FOR UNASSIGNED ELEMENTS ?
NO
1
YES
EPMA
3.3.2
ELEMENTAL RATIOS ESTABLISHED FOR SINGLE PARTICLES FOR ELEMENTS ≥ C
CAN UNASSIGNED MATE COMPOUNDS BE IDENTIFIED WITH THESE RATIOS ?
YES
LIST COMPOUNDS WITH CONCENTRATION ESTIMATE BASED ON ELEMENTAL VALUES
1
NO
IS THERE UNIDENTIFIED CRYSTALLINE MATERIAL ?
NO
1
YES
TEM-SAED
3.3.3
DETERMINE XRD SPECTRA OF SINGLE PARTICLE OR AREA IN PARTICLE
SPECIFIC COMPOUND IDENTIFIED
ELEMENTAL DATA USED TO QUANTIFY
HAVE ALL UNASSIGNED MEG COMPOUNDS EXCEEDING MATE VALUES BEEN FOUND ?
NO
1
YES
IS FURTHER CHARACTERIZATION JUSTIFIED ?
NO
LIST UNASSIGNED FRACTION OF KNOWN ELEMENTAL COMPOSITION
YES
7
BASED ON SOLUBILITY AND ELEMENTAL DATA SELECT SEPARATION SCHEME
MAGNETIC SEPARATION
DENSITY GRADIENT SEPARATION
SELECTIVE DISSOLUTION SEPARATION
3.3.4
LESS COMPLEX MATRIX
SSMS OF FRACTIONS
DOES FRACTION CONTAIN UNASSIGNED MATE ELEMENT ?
NO
STORE FRACTION
YES
6

Figure 3-9. Logic Flow for Individual Particle Characterization

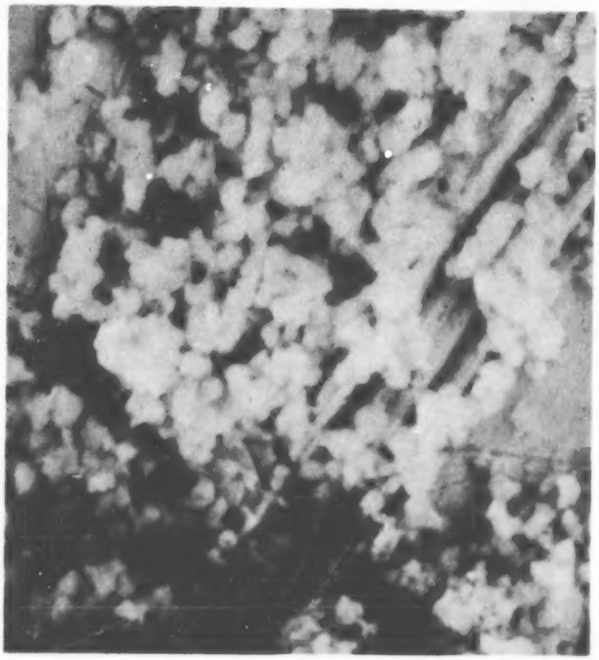


Figure 3-10. SEM at 3000X of Sample S-2-3. Uniform appearing spheres (approximately 10 microns) with aggregates with 40-350 microns in size. Spheres identified as predominantly calcium. (Anions such as SO_4 are not determined by this technique.)

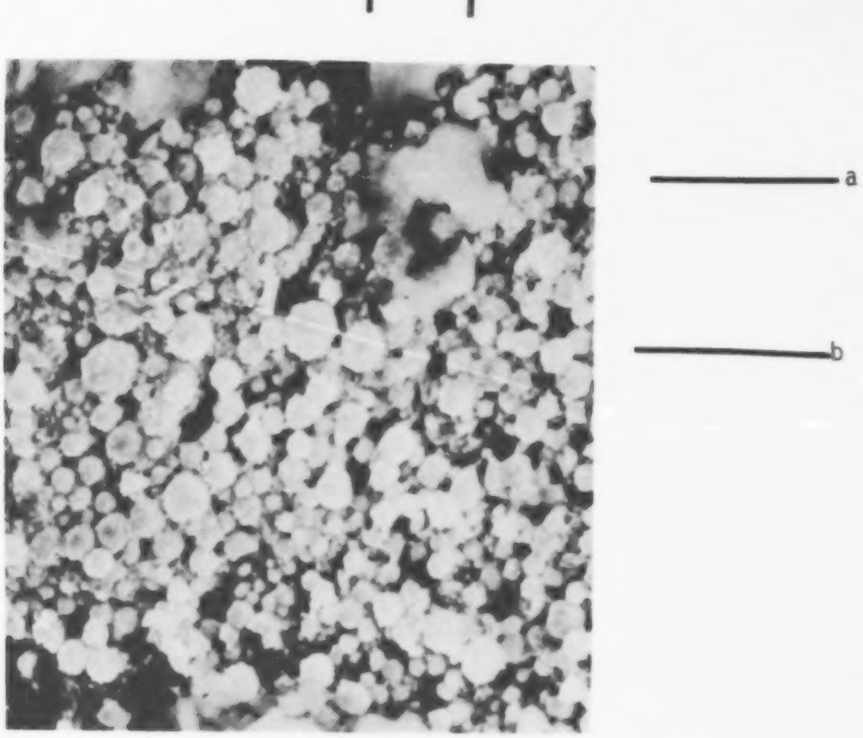


Figure 3-11. SEM at 3000X of Sample S-2-4. Predominant species are spheres (1b) of approximately 25-5 microns with very irregular surfaces giving the impression that they are composed of numerous smaller fused spheres. Also present are large, 60-30 microns, irregular flakes (2a). The spheres (1b) are composed of calcium. The flakes (2a) are predominantly silicon.

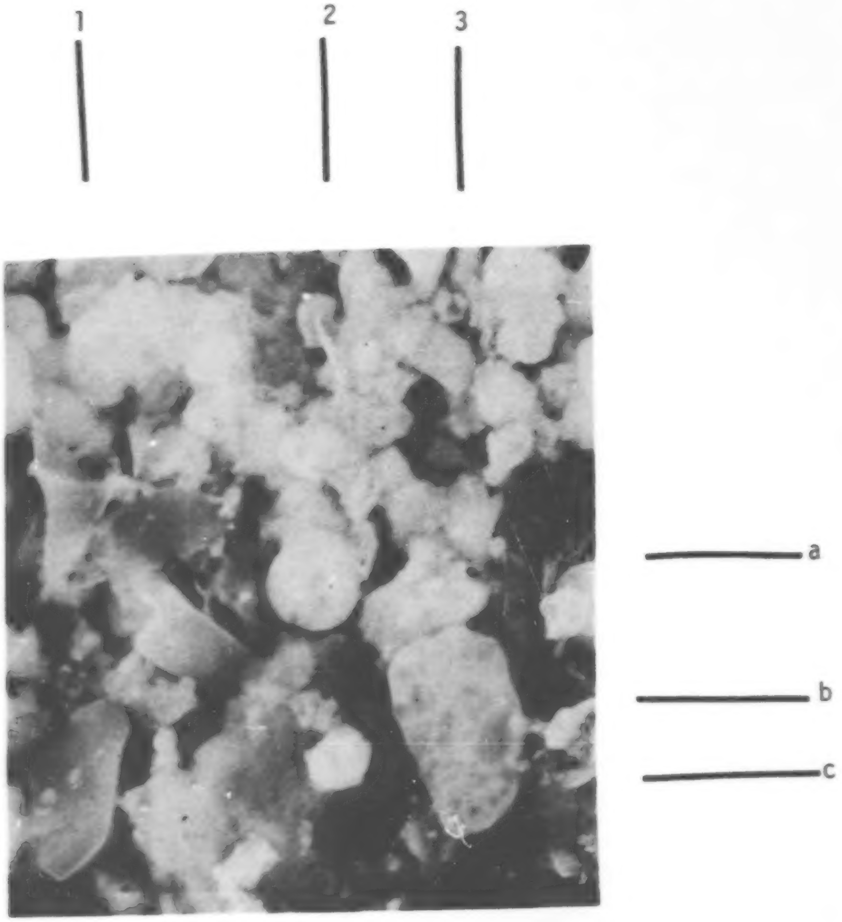


Figure 3-12. SEM at 3000X of Sample S-2-5. These particulates are very crystalline and irregular in nature. There are some spheres present with highly irregular porous surfaces. The spheres (2a) range in size from 10 to 40 microns. The thick appearing fused material (3b) range up to 100 x 60 microns, thin flakes (1c) 40 x 90 microns. The spheres (2a) are composed of calcium. The fused crystalline material in area 1c is predominantly silicon with iron present, and in area 3b silicon is major but calcium is also present (fused in the silicon matrix).

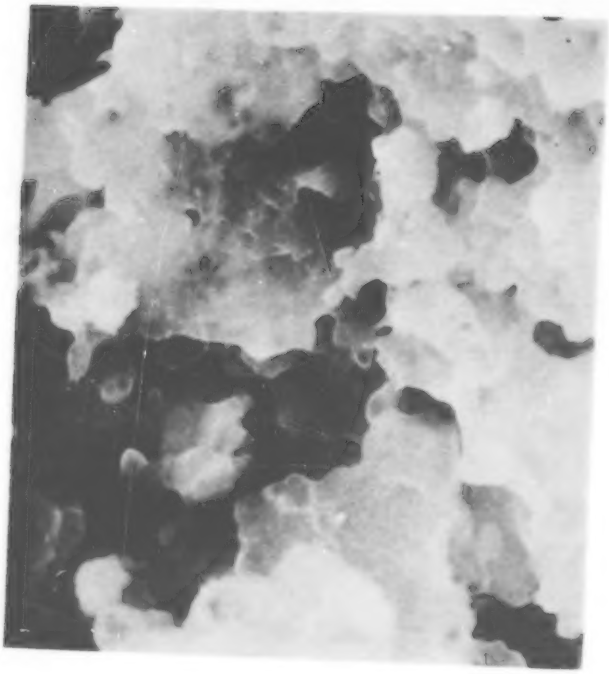


Figure 3-13. SEM at 3000X of Sample S-2-6. Highly fused particulates, large (4000 microns), uniform, porous and thin. Silicon is the major component with potassium and calcium present.

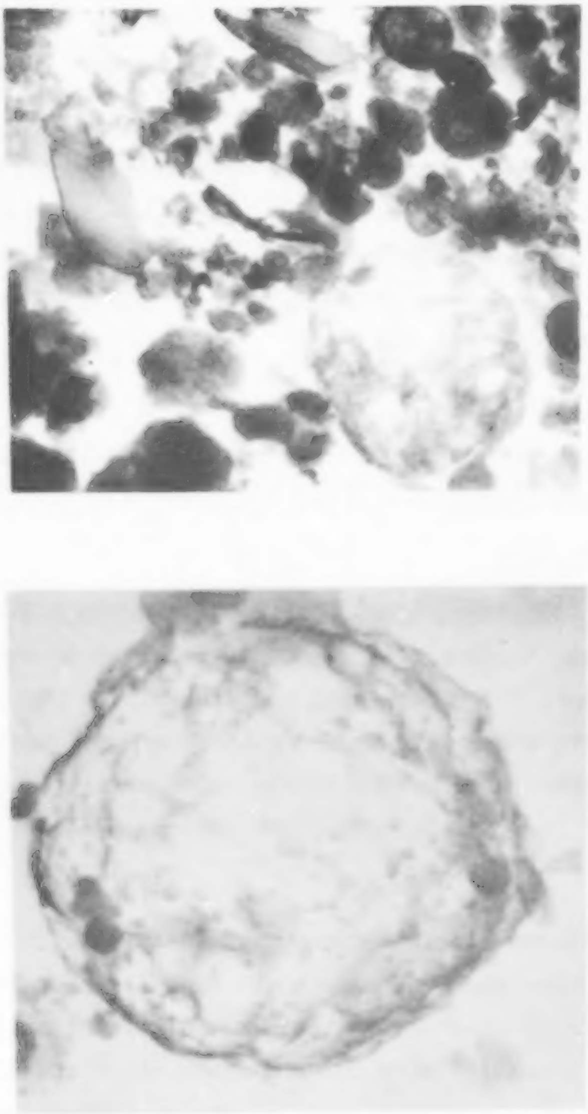


Figure 3-14. SEM at 3000X and 6000X of Sample S-2-7. Very irregular spheres 25-130 microns, and thin flakes. The larger spheres (130 microns) are porous and smaller spheres (5-10 microns) adhere to their surface. The major sphere component is silicon with calcium present in the matrix. The major component of the smaller spheres is calcium with silicon present in the matrix. The flakes vary in dominant species but show both silicon and calcium as major components.

Research Laboratories, Model EMX. The backscattered X-rays produced when the sample was irradiated were imaged. This was done to verify areas which were high in particular elements and to establish the association between those elements found present in prior analyses, e.g., are Ca and S present at the same sample location?

3.3.2.1 Sample Preparation

The samples were analyzed directly after SEM work and remained mounted on the gold sample stages.

3.3.2.2 EPMA Results

The gallery of photographs (Figures 3-15 through 3-19) which follows indicates the relationship of elements to location on each particle analyzed. Figure 3-17, Sample S-2-5, exhibits the distinctive characterization of an area on the sample where calcium and silicon are not present at same location. All the other samples are fairly uniform in elemental dispersion. Table 3-12 lists all the elements identified by EPMA in each sample.

3.3.3 TEM-SAED

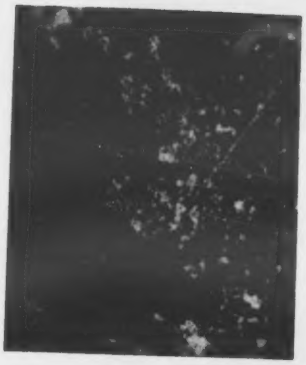
The transmission electron microscope analysis with selective area electron diffraction was employed to assess the uniqueness in composition of the individual particles observed in the SEM. All prior analyses had indicated that the emission samples were uniform mixtures of compounds without distinctive particle sizes, ranges, colors, or shapes indicative of individual species. The system used in this portion of the inorganic work was an RCA Model EMU-3H. It has a resolution of 10Å and a 100 kV beam. The accuracy of the determined d-spacings is ±0.5.

3.3.3.1 Sample Preparation

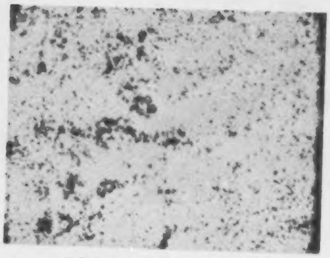
The samples (S-2-3, S-2-4, S-2-5, S-2-6, and S-2-7) were mounted on a copper mesh screen coated with graphite. This provides for electron transmission and conductance. They were then coated with carbon to secure them during analysis.

3.3.3.2 TEM-SAED Results

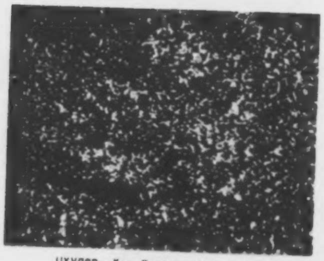
Figures 3-20 through 3-24 are the TEM images of the samples. The arrows indicate the areas were SAED patterns were generated. The



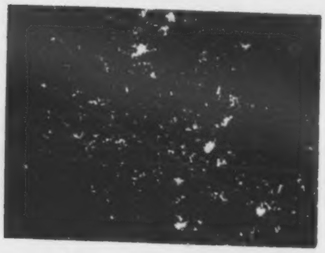
FLYASH
S-2-3



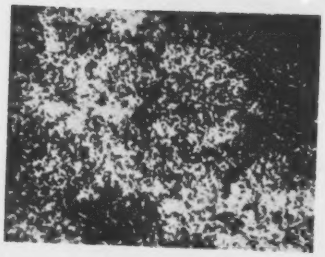
Calcium, Kα, Backscattered Image



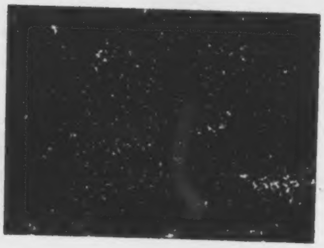
Oxygen, Kα, Backscattered Image



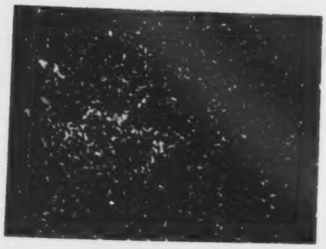
Silicon. Kα, Backscattered Image



Sulfur, Kα, Backscattered Image

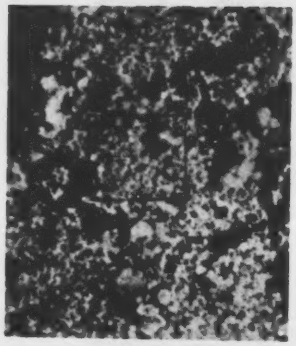


Iron, Kα, Backscattered Image

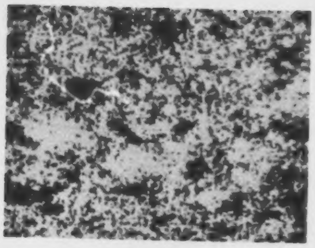


Potassium, Kα, Backscattered Image

Figure 3-15. EPMA of Sample S-2-3

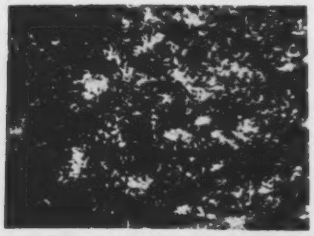


FLYASH
S-2-4

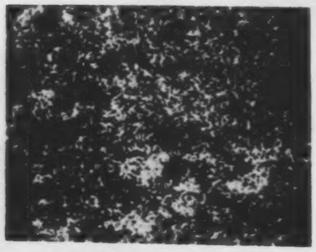


Calcium, Kα, Backscattered Image

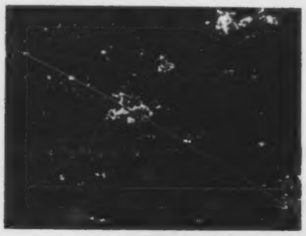
Oxygen, Kα, Backscattered Image



Si, Kα, Backscattered Image



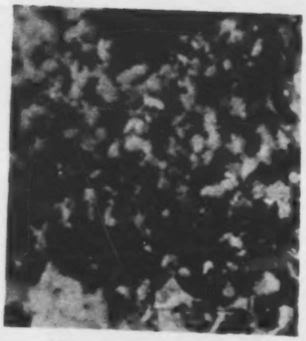
Sulfur, Kα, Backscattered Image



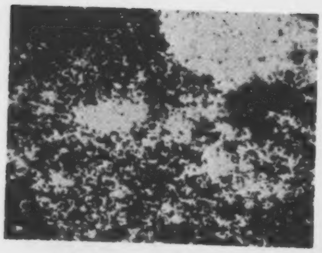
Iron, Kα, Backscattered Image

Potassium, Kα, Backscattered Image

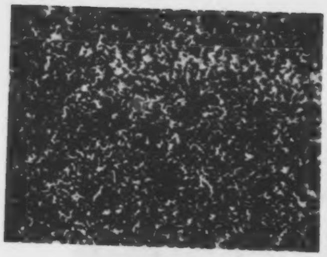
Figure 3-16. EPMA of Sample S-2-4



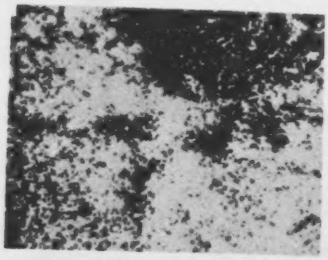
FLYASH
S-2-5



Calcium, Kα, Backscattered Image

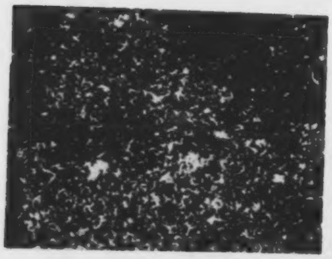


Oxygen, Kα, Backscattered Image

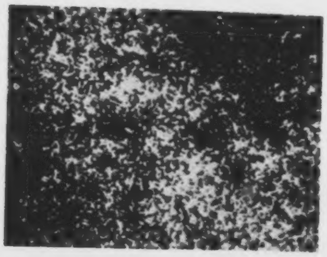


Silicon, Kα, Backscattered Image

Sulfur, Kα, Backscattered Image

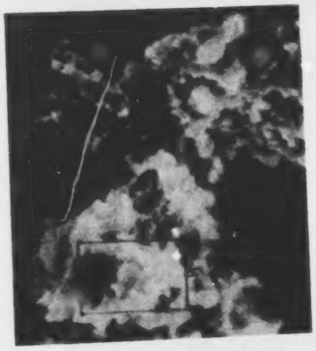


Iron, Kα, Backscattered Image

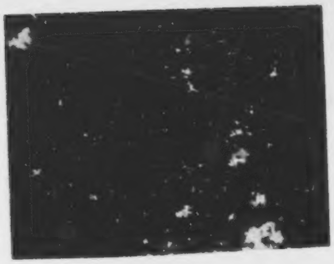


Potassium, Kα, Backscattered Image

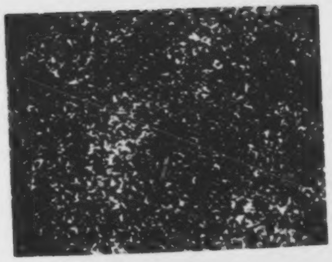
Figure 3-17. EPMA of Sample S-2-5



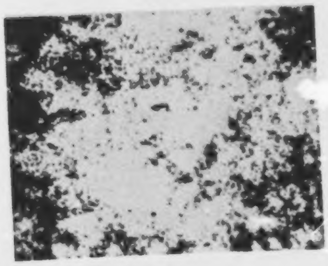
FLY ASH
S-2-6



Calcium, Kα, Backscattered Image

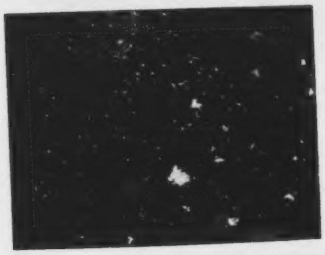


Oxygen, Kα, Backscattered Image

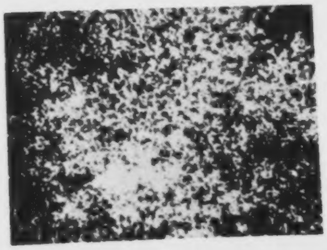


Silicon, Kα, Backscattered Image

Sulfur, Kα, Backscattered Image

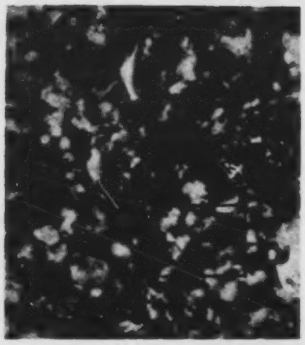


Iron, Kα, Backscattered Image

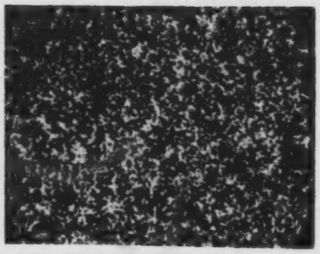


Potassium, Kα, Backscattered Image

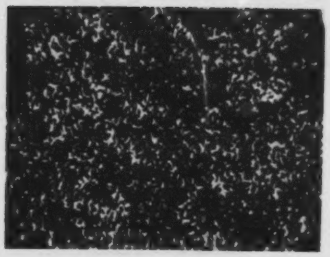
Figure 3-18. EPMA of Sample S-2-6



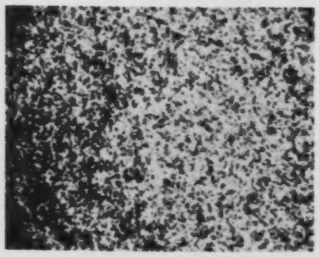
FLYASH
S-2-7-3



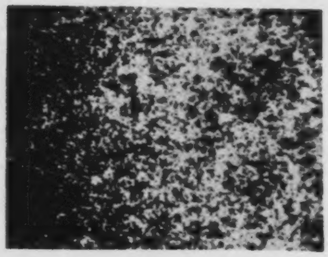
Calcium, Kα, Backscattered Image



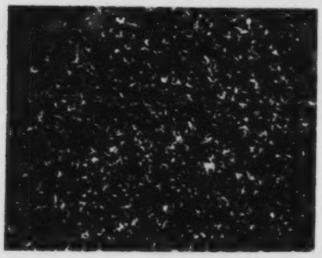
Oxygen, Kα, Backscattered Image



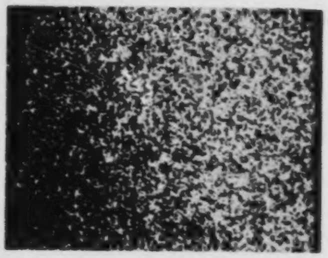
Silicon, Kα, Backscattered Image



Sulfur, Kα, Backscattered Image



Iron, Kα, Backscattered Image



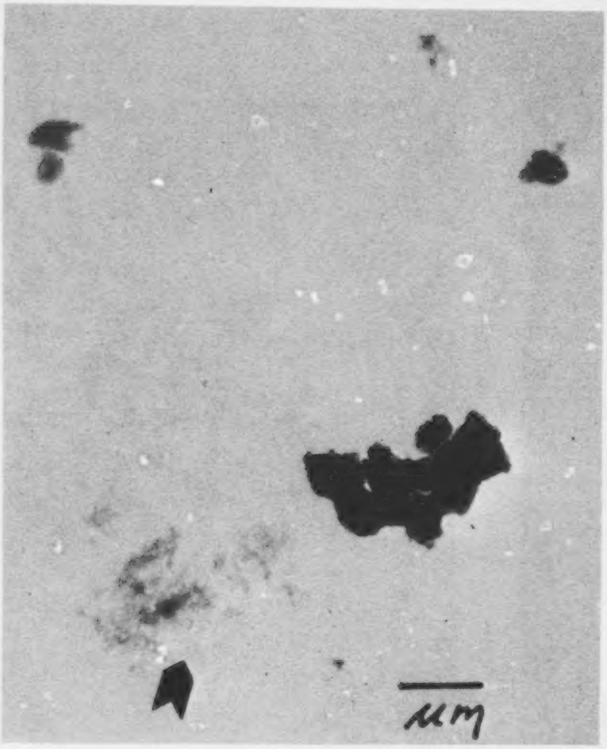
Potassium, Kα, Backscattered Image

Figure 3-19. EPMA of Sample S-2-7

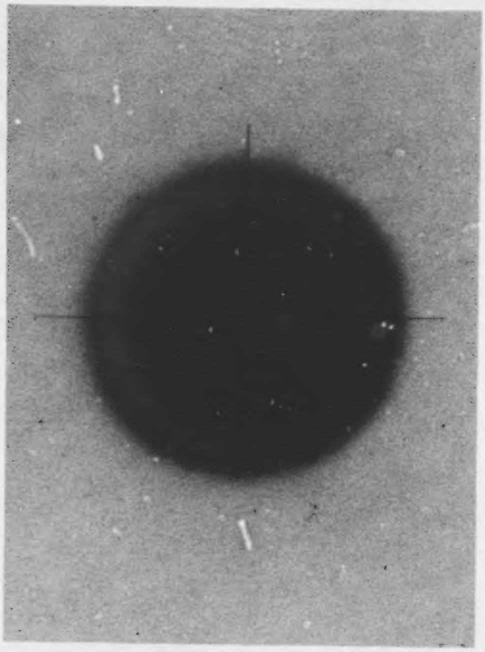
Table 3-12. EPMA Identified Elements

Sample Code	Elements Detected	Relative Abundance*
S-2-3	Calcium	Major
	Sulfur	Medium
	Oxygen	Medium
	Silicon	Medium
	Iron	Low
	Potassium	Low
S-2-4	Calcium	Major
	Sulfur	Medium
	Oxygen	Medium
	Silicon	Medium
	Iron	Low
	Potassium	Low
	Chlorine	Trace
	Magnesium	Trace
	Aluminum	Trace
S-2-5	Calcium	Major
	Sulfur	Medium
	Oxygen	Major
	Silicon	Major
	Iron	Medium
	Potassium	Medium
	Aluminum	Low
S-2-6	Calcium	Medium
	Sulfur	Medium
	Oxygen	Medium
	Silicon	Major
	Iron	Low
	Potassium	Medium
S-2-7	Calcium	Major
	Sulfur	Major
	Oxygen	Major
	Silicon	Major
	Iron	Medium
	Potassium	Medium
	Aluminum	Low
	Magnesium	Low
	Chlorine	Low
	Titanium	Low

*Major	>10%
Medium	5-10%
Low	1-5%
Trace	<1%



TEM Image, Sample S-2-3.
Crystalline appearing
particles were analyzed
using SAED.

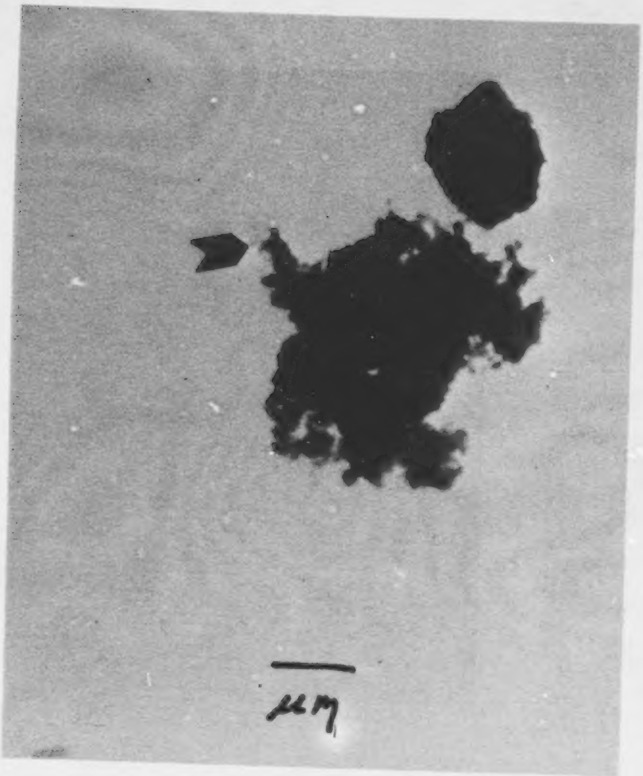


Electron Diffraction Pattern

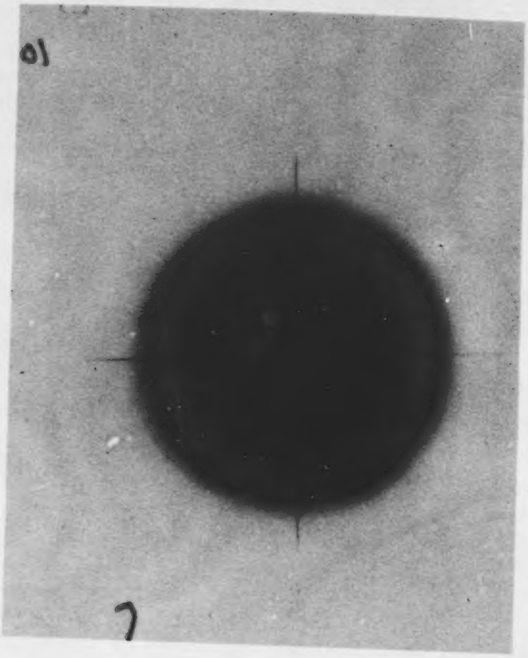
Crystalline Material Analysis

Determined d-spacings	Compound Identified	Literature d-spacings
4.19	SiO_2	4.26
3.59		3.34
1.93		1.82
1.67		1.54

Figure 3-20. TEM/SAED Analysis of Sample S-2-3



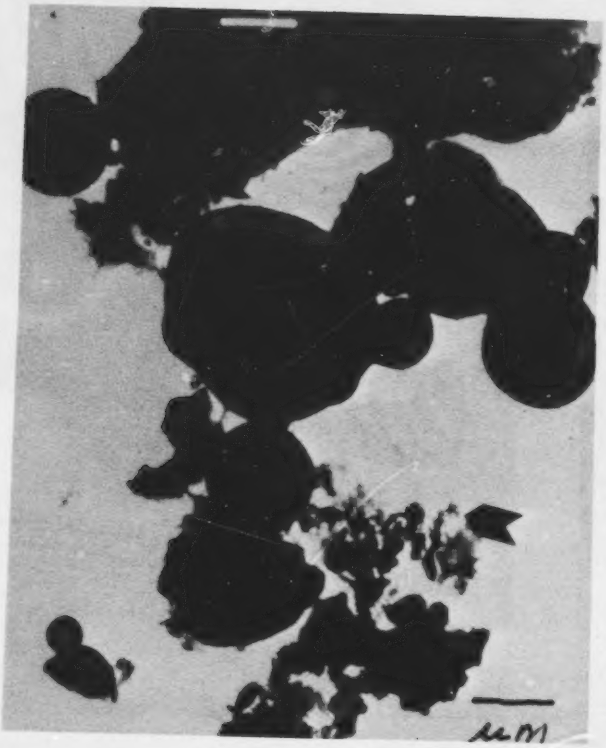
TEM Image, Sample S-2-4.
Thin area analyzed using
SAED.



Electron Diffraction Pattern

Area Analyzed		
Determined d-spacings	Compound Identified	Literature d-spacings
2.64	Fe_2O_3	2.69
1.68		1.69
1.40		1.48

Figure 3-21. TEM/SAED Analysis of Sample S-2-4

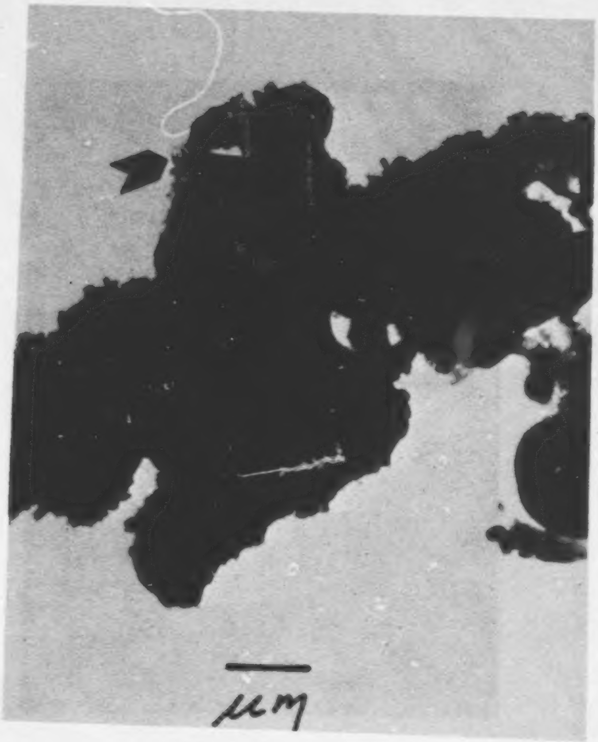


TEM Image, Sample S-2-5.
Thin area analyzed using
SAED.

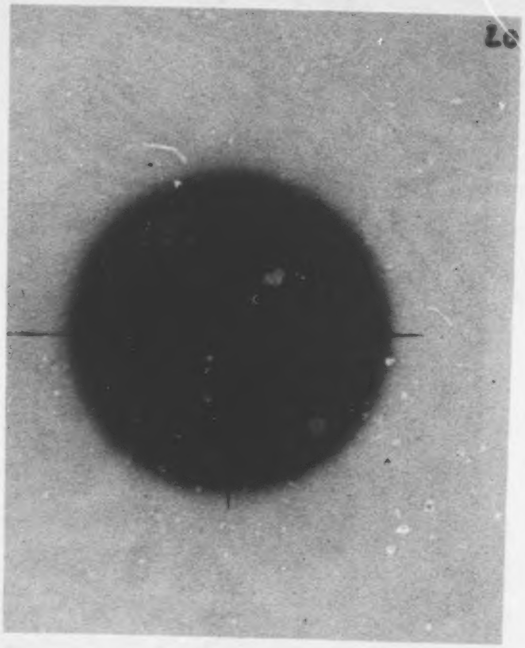
Electron Diffraction Pattern

Area Analyzed		
Determined d-spacings	Compound Identified	Literature d-spacings
4.41 3.14 2.64 2.28 1.93 1.48	SiO_2	4.26 3.34 2.46 2.28 1.82 1.54

Figure 3-22. TEM/SAED Analysis of Sample S-2-5



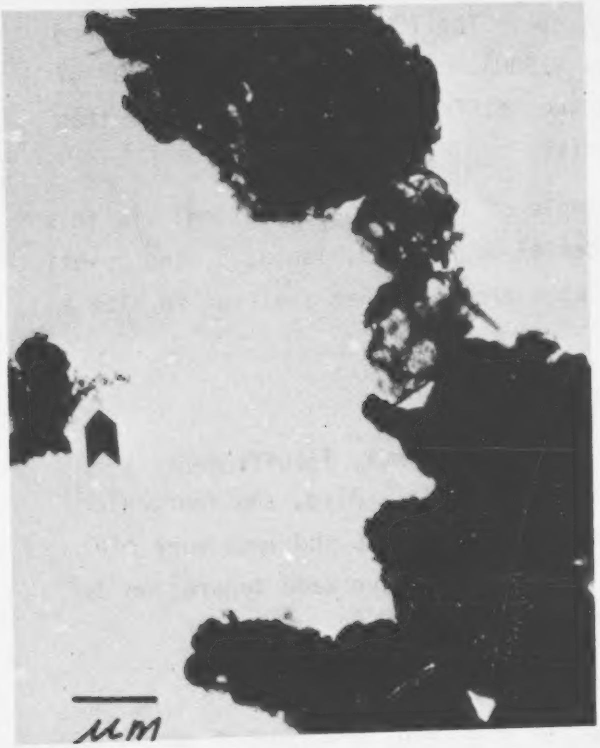
TEM Image, Sample S-2-6.
Thin area analyzed using SAED.



Electron Diffraction Pattern

Area Analyzed		
Determined d-spacings	Compound Identified	Literature d-spacings
3.33	Fe_2O_3	3.6
2.51		2.51
1.68		1.69
1.26		1.48

Figure 3-23. TEM/SAED Analysis of S-2-6



TEM Image, Sample S-2-7. Thin area analyzed using SAED.

Electron Diffraction Pattern

Area Analyzed		
Determined d-spacings	Compound Identified	Literature d-spacings
4.57	SiO_2	4.26
2.28		2.28
1.52		1.54
2.64	Fe_2O_3	2.69
1.68		1.69
2.56		2.51

Figure 3-24. TEM/SAED Analysis of S-2-7

interpretation of the SAED patterns has a general uncertainty about it because of the accuracy of the technique. The TEM images are not of good quality due to the sample thickness, >1500Å. In most cases thin areas of the sample had to be chosen for electron diffraction analysis rather than uniquely appearing crystalline material.

Only sample S-2-3 is a good example of TEM/SAED application. In this case a definite fine crystalline material was imaged, isolated, and identified as silica. These fine particulates are less than a micron in size and, therefore, respirable.

3.3.4 Sample Fractionation Techniques

In the case of the FBC samples, there was simply insufficient quantity to attempt a sample fractionation matrix. Also, the inorganic data generated had indicated that compounds, elements and ions were dispersed and bound in a silica matrix. This would have made separation difficult and success would not be likely.

3.4 CONCLUSIONS BASED ON LEVEL 2 INORGANIC ANALYSES

The inorganic data are summarized on the Level 1 - Level 2 data reduction and presentation tables (Table 3-13). Quantitation is based on the data generated in Section 3.1.3 and qualitative compound identification is based directly on those compound identification techniques employed.

Assumptions which were made in completing these tables were based on the fact that for most inorganic MEG compounds the MATE values are based on the elemental abundance. Therefore, if the elemental concentration exceeds the MATE and compound types for that element have been identified, then they too would exceed the MATE.

The leachates are reported on a separate set of tables (Table 3-14).

Table 3-13. Level 2 Data on FBC Emission Samples

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/1 HEALTH	MATE WATER µg/1 ECOLOGY	MATE LAND µg/1 HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE* µg/m³ (ppm) µg/1	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
27. LITHIUM	Li	2.2×10	3.3×10^2	3.8×10^2	7.0×10^{-1}	7.5×10^{-1}	6.9×10^2		Exceeds Mate				
	Li^+	2.2×10	3.3×10^2	3.8×10^2									
	LiF (as Li)	2.2×10	3.3×10^2	3.8×10^2									
	Li_2CO_3 (as Li)	2.2×10	3.3×10^2	3.8×10^2									
	LiH	2.5×10	3.8×10^2	N									
28. SODIUM	Na^+	5.3×10^4	8.0×10^5	N	1.6×10^3	N	5.4×10^5		Exceeds Mate - See Note 1				
	NaOH	2.0×10^3	3.0×10^4	N	6.0×10	N							
29. POTASSIUM	KOH	2.0×10^3	3.0×10^4	N	6.0×10	N							
	K	N	N	N	N	N	6.7×10^4		See Note 1				
	K^+ (as K)	N	N	2.3×10^4	N	4.6×10							
30. RUBIDIUM	Rb^{+1}	1.21×10^5	1.82×10^6	N	3.64×10^3	N							
31. CESIUM	CS^{+1}	8.19×10^4	1.23×10^6	N	2.46×10^3	N							
32. BERYLLIUM	Be	2.0	3.0×10	5.5×10	6.0×10^{-2}	1.1×10^{-1}	N.D.						
	Be^{++}	2.0	3.0×10	5.5×10	6.0×10^{-2}	1.1×10^{-1}	N.D.		See Note 1				
	BeO (as Be)						N.D.						
	$BeO \cdot Al_2O_3 \cdot SiO_2$ (as Be)	2.0	3.0×10	5.5×10	6.0×10^{-2}	1.1×10^{-1}	N.D.						
33. MAGNESIUM	Magnesium, Mg	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2	7.34×10^4		Exceeds Mate				
	Magnesium Ion, Mg^{++}	6.01×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2	3.7×10^3		See Note 1				
	Magnesium Oxide, MgO	1.01×10^4	1.5×10^5	1.0×10^5	3.0×10^2	2.0×10^2		Present Based on Compound Data					
	Magnesium Fluoride, MgF_2 (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2	N.D.						
	Magnesium Sulfate, $MgSO_4$ (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2		Present Based on Compound Data					
	Magnesite, $MgCO_3$ (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2	N.D.						
	Dolomite, $MgCO_3 \cdot CaCO_3$ (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2	N.D.						
	Asbestos (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2	N.D.						
34. CALCIUM	Calcium Ion, Ca^{++}	1.6×10^4	2.4×10^5	1.6×10^4	4.8×10^2	3.2×10	9.5×10^5		Exceeds Mate - See Note 1				
	Calcium Fluoride, CaF_2	N	N	N	N	N	N.D.						
	Calcium Carbonate, $CaCO_3$	N	N	N	N	N	Present Based on Compound Data						
	Calcium Sulfate, $CaSO_4$	N	N	N	N	N	Present Based on Compound Data						
	Dolomite, $MgCO_3 \cdot CaCO_3$	N	N	N	N	N	N.D.						

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7 N.D. Not Detected

1. Based on Level 2 leachate study of sample S-2-6.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE* µg/m³ (ppm) µg/l	RATIO SAMPLE / MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
35. STRONTIUM	Strontium	3.1×10^3	4.6×10^4	N	9.2×10	N							
	Strontium Ion, Sr^{++} (as Sr)	3.1×10^3	4.6×10^4	N	9.2×10	N	1.4×10^4		Exceeds Mate				
	Strontium Fluoride, SrF_2 (as Sr)	3.1×10^3	4.6×10^4	N	9.2×10	N							
	Strontium Sulfate, $SrSO_4$ (as Sr)	3.1×10^3	4.6×10^4	N	9.2×10	N	N.D.						
36. BARIUM	Barium, Ba	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0	Present Based on Compound Data						
	Barium Ion, Ba^{++} (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Sulfide, BaS (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0	N.D.						
	Barium Thio-carbonate, $BaCS_3$ (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Fluoride, BaF_2 (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Carbonate, $BaCO_3$ (as Ba)	5.0×10^2	5.0×10^3	8.5×10^3	1.0×10	5.0							
	Barium Sulfate, $BaSO_4$ (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
37. BORON	Boron, B	3.1×10^3	4.7×10^4	2.5×10^4	9.3×10	5.0×10							
	Borate, BO_3 (as B)	3.1×10^3	4.7×10^4	2.5×10^4	9.3×10	5.0×10	N.R.						
	Metaborate, BO_2^- (as B)	3.1×10^3	4.7×10^4	2.5×10^4	9.3×10	5.0×10							
	Boron Oxide, B_2O_3	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
38. ALUMINUM	Aluminum, Al	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.01							
	Aluminum Ion, Al^{+++}	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	N							
	Bauxite, $Al_2O_3 \cdot 3H_2O$ (as Al)	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.0	5.2×10^4		Exceeds Mate - See Note 1				
	Hydrated Aluminum Silicate (as Al)	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.0							
	Alums $[M\,Al\,(SO_4)_2] \cdot (H_2O)_x$ (as Al)	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.0							
	Aluminum Oxide, Al_2O_3	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
39. GALLIUM	Gallium, Ga	5.0×10^3	7.4×10^4	N	1.5×10^2	N	Present Based on Compound Data						
	Elemental Species, Ga	5.0×10^3	7.4×10^4	N	1.5×10^2	N	N.R.						
	Gallous, Ga^{+1} (as Ga)	5.0×10^3	7.4×10^4	N	1.5×10^2	N							

TABLE KEY:

1. TEST METHOD
    1. STANDARD
    2. DEVELOP-MENTAL
    3. UNKNOWN

    A. AAS
    B. XRD
    C. WET CHEMICAL
    D. ESCA
    E. GC/MS
2. EXPECTED TEST SUCCESS:
    1. HIGH
    2. MODERATE
    3. UNKNOWN
3. TEST COST
    1. REASONABLE
    2. MODERATE
    3. HIGH
4. SAMPLE ALIQUOT
    1. ADEQUATE
    2. MARGINAL
    3. INADEQUATE
    4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7.

N.D. Not Detected
N.R. Not Required on Level 2

1. Based on Level 2 leachate study of sample S-2-6.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE* µg/m^3 (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Gallic, Ga^{+3} (as Ga)	5.0 x 10^3	7.4 x 10^4	N	1.5 x 10^2	N	N.R.						
	Gallium Sesquioxide, Ga$_2$O$_3$ (as Ga)	5.0 x 10^3	7.4 x 10^4	N	1.5 x 10^2	N							
40. INDIUM	Indium, In	1.0 x 10^2	1.5 x 10^3	N	3.0	N	N.R.						
	Indium Ion, In^{+3}	1.0 x 10^2	1.5 x 10^3	N	3.0	N							
41. THALLIUM	Thallium, Tl	1.0 x 10^2	1.5 x 10^3	N	3.0	N	N.D.						
	Thallous, Tl^{+1}	1.0 x 10^2	1.5 x 10^3	N	3.0	N							
	Thallic, Tl^{+3}	1.0 x 10^2	1.5 x 10^3	N	3.0	N							
42. CARBON	Elemental Carbon	3.5 x 10^3	5.3 x 10^4	N	1.6 x 10^2	N							
	Coal	N	N	N	N	N							
	Carbide, C-	N	N	N	N	N							
	Carbonate, CO$_3$$^{-2}$	N	N	N	N	N	Present Based on Compound Data						
	Bicarbonate, HCO$_3$	N	N	N	N	N							
	Carbonyl, CO=	N	N	N	N	N							
	Carbon Monoxide	4.0 x 10^3 (35)	6.0 x 10^5	6.0 x 10	N/A	N/A							
	Carbon Dioxide	9.0 x 10^6 (5000)	N	N	N/A	N/A							
43. SILICON	Silane, SiH$_4$	7.0 x 10^2	1.1 x 10^4	N	N	2.1 x 10	N.R.						
	Silicon, Si	1.0 x 10^4	1.5 x 10^5	N	3.0 x 10^2	N	1.3x10^7		Exceeds Mate				
	Orthosilicate, SiO$_4$$^{-2}$	N	N	N	N	N							
	Metasilicate, SiO$_3$$^{-2}$	N	N	N	N	N							
	Silicon Dioxide, SiO$_2$	1.0 x 10^4	1.5 x 10^5	N	3.0 x 10^2	N	Present Based on Compound Data						
	Silicon Disulfide, SiS$_2$	N	N	N	N	N							
	Silicon Carbide, SiC	1.0 x 10^4	1.5 x 10^5	N	3.0 x 10^2	N							
44. GERMANIUM	Germanium, Ge	5.6 x 10^2	8.4 x 10^3	N	1.7 x 10	N	N.R.						
	Germanous, Ge^{+2} (as Ge)	5.6 x 10^2	8.4 x 10^3	N	1.7 x 10	N							
	Germanic, Ge^{+4} (as Ge)	5.6 x 10^2	8.4 x 10^3	N	1.7 x 10	N							
	Germanous Sulfide, GeS (as Ge)	5.6 x 10^2	8.4 x 10^3	N	1.7 x 10	N							
	Germanic Sulfice, GeS$_2$ (as Ge)	5.6 x 10^2	8.4 x 10^3	N	1.7 x 10	N							
	Germane, GeH$_4$ (as Ge)	5.6 x 10^2	8.4 x 10^3	N	1.7 x 10	N							
	Germanium Oxide, GeO$_2$ (as Ge)	5.6 x 10^2	8.4 x 10^3	N	1.7 x 10	N							

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7.

N.D. Not Detected
N.R. Not Required on Level 2

1. Based on Level 2 leachate study of sample S-2-6.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE* µg/m³ (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
45. TIN	Tin Oxide, SnO_2	1.0×10^4	1.5×10^5	N	3.0	N	N.R.						
	Tin, Sn	N	N	N	N	N							
	Stannous, Sn^{+2}	N	N	N	N	N							
	Stannic, Sn^{+4}	N	N	N	N	N							
46. LEAD	Lead, Pb	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	3.3×10^3		Exceeds Mate				
	Elemental Lead, Pb	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Plumbous, Pb^{+2}	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Plumbic, Pb^{+4} (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Lead Monoxide, PbO (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Lead Sulfate, $PbSO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	Present	Based on Compound Data					
	Lead Sulfate, Pbs (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Lead Carbonate, $PbCO_3$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	Present	Based on Compound Data					
	Lead Phosphate, $Pb_3(PO_4)_2$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Lead Chromate, $PbCrO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Lead Molybdate, $PbMoO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Lead Arsenate, $PbHAsO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
47. NITROGEN	Hydrazine	1.5×10^2 (.1)	2.3	N	4.5	N	N.R.						
	Alkali Cyanides, NaCN, KCN	5.0×10^3	5.0×10^2	2.5×10	1.0	5.0×10^{-2}							
	Nitric Acid, HNO_3	5.0×10^3	7.5×10^4	4.5×10^2	1.5×10^3	9.0×10^{-1}							
	Nitrogen Oxides, N_2O, NO_2, N_2O_4, N_2O_3, N_2O_5	9.0×10^3	1.4×10^5	N	N/A	N/A							
	Hydrogen Cyanide, HCN	1.1×10^4 (10)	5.0×10^2	2.5×10	1.0	5.0×10^{-2}							
	Ammonia, NH_3	1.8×10^4 (25)	2.5×10^3	5.0×10	5.0	1.0×10^{-1}							
	Cyanogen, C_2N_2	2.0×10^4	1.0×10^3	2.5×10	2.0	5.0×10^{-2}							
	Nitride, N=	N	N	N	N	N							
	Nitrate, NO_3^-	N	N	N	N	N	N.D.	Based on Compound Data					
	Nitrite, NO_2^-	N	N	N	N	N	N.D.	Based on Compound Data					
	Ammonium, NH_4^+	N	N	N	N	N	N.D.	Based on Compound Data					

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-6.

N.D. Not Detected
N.R. Not Required on Level 2

1. Based on Level 2 leachate study of sample S-2-6.

Table 3-13. Level 2 Data on FBC Emission Samples (continued)

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE* µg/m³ (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
48. PHOSPHORUS	Phosphorus, P	1.0×10^2	1.5×10^4	5.0×10^{-1}	3.0×10	1.0×10^{-3}	N.D.			See Note 1			
	Phosphite, PO_3^{-3} (as P)	1.0×10^2	1.5×10^4	5.0×10^{-1}	3.0×10	1.0×10^{-3}	N.D.			See Note 1			
	Biphosphate, $H_2PO_4^-$ (as P)	1.0×10^2	1.5×10^4	5.0×10^{-1}	3.0×10	1.0×10^{-3}							
	Phosphine, PH_3	4.0×10^2 (0.3)	6.0×10^3	N	N/A	N/A							
	Phosphoric Acid, H_3PO_4	1.0×10^3	1.5×10^4	4.5×10^3	3.0×10	9.0							
	Phosphorus Pentasulfide	1.0×10^3	1.5×10^4	N	3.0×10	N							
	Phosphate, PO_4^{-3}	N	N	N	N	N	N.D.			See Note 1			
49. ARSENIC	Arsenic, As	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}	5.0×10^{-1}				See Note 1		
	Metallic Arsenic	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}	5.0×10^{-1}				See Note 1		
	Arsenous, As^{+3}	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}	5.0×10^{-1}				See Note 1		
	Arsenic, As^{+5}	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}	Present Based on Compound Data						
	Arsenate, AsO_4^{-3} (as As)	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}	Present Based on Compound Data						
	Arsenite, AsO_3^{-3} (as As)	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsenide, As^{-3} (as As)	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsine, AsH_3	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}							
	Arsenic Trioxide, As_2O_3	2.0×10	2.5×10^2	5.0×10^1	5.0×10^{-1}	1.0×10^{-1}	Present Based on Compound Data						
50. ANTIMONY	Antimony Trioxide, Sb_2O_3	5.0×10^1	7.5×10^2	2.0×10^2 (as Sb)	1.5×10	4.0×10^{-1} (as Sb)	N.R.						
	Antimony Metal, Sb	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Antimonous, (stibnous) Sb^{+3}	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Antimonic (stibnic) Sb^{+5}	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Stibine, SbH_3 (as Sb)	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Antimonous Sulfide, Sb_2S_3	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
	Antimony, Sb	5.0×10^2	7.5×10^3	2.0×10^2	1.5×10^1	4.0×10^{-1}							
51. BISMUTH	Bismuth, Bi	4.1×10^2	6.1×10^3	N	1.2×10^1	N	N.R.						
	Elemental Bismuth, Bi	4.1×10^2	6.1×10^3	N	1.2×10^1	N							
	Bismuthous, Bi^{+3} (as Bi)	4.1×10^2	6.1×10^3	N	1.2×10^1	N							
	Bismuthic, Bi^{+5} (as Bi)	4.1×10^2	6.1×10^3	N	1.2×10^1	N							

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GS/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

*Summation of S-2-5, S-2-6 and S-2-7.

1. Based on Level 2 leachate study of sample S-2-6.

N.D. Not Detected.

N.R. Not Required on Level 2.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE* µg/m^3 (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
52. OXYGEN	Ozone, O_3	2.0×10^2 (0.1)	N/A	N/A	N/A	N/A	N.R.						
53. SULFUR	Rhombic Sulfur, S_8	N	N	N	N	N							
	Sulfide, S^{-2}	N	N	N	N	N	Present	Based on Compound Data					
	Sulfate, SO_4^{-2}	N	N	N	N	N	Present	Based on Compound Data					
	Sulfite, SO_3^{-2}	N	N	N	N	N							
	Thiocyanate, SCN^-	N	N	N	N	N							
	Sulfur Trioxide, SO_3	N	N	N	N	N							
	Sulfuric Acid, H_2SO_4	1.0×10^3	1.5×10^4	4.5×10^2	3.0×10^1	9.0×10^2							
	Sulfur Dioxides, SO_2	1.3×10^4	2.0×10^5	N	4.0×10^2	N							
	Hydrogen Sulfide, H_2S	1.5×10^4 (10)	2.3×10^4	1.0×10^1	N/A	N/A							
	Carbon Disulfide, CS_2	6.0×10^4 (20)	9.0×10^5	1.0×10^4	N/A	N/A							
	Carbonyl Sulfide, COS	4.4×10^5	N/A	N/A	N/A	N/A							
54. SELENIUM	Selenium, Se	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}	N.R.						
	Elemental Selenium, Se	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Selenide, Se^{-2}	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Selenites, SeO_3^{-2} (as Se)	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Selenates, SeO_4^{-2} (as Se)	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Hydrogen Selenide, H_2Se	2.0×10^2 (.05)	5.0×10^1 (as Se)	2.5×10^1 (as Se)	1.0×10^{-1} (as Se)	5.0×10^{-2} (as Se)							
	Carbon Diselenide, CSe_2 (as Se)	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Selenium Dioxide, SeO_2 (as Se)	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
55. TELLURIUM	Tellurium, Te	1.0×10^2	1.5×10^3	N	3.0×10	N	N.R.						
	Telluride, Te^{-2}	1.0×10^2	1.5×10^3	N	3.0×10	N							
	Tellurite, TeO_3^{-2} (as Te)	1.0×10^2	1.5×10^3	N	3.0×10	N							
	Tellurate, TeO_4 (as Te)	1.0×10^2	1.5×10^3	N	3.0×10	N							
56. FLUORIDE	Fluoride Ion, F^-	2.5×10^3	3.8×10^4	N	7.5×10^1	N	N.R.						
	Hydrogen Fluoride, HF	2.0×10^3	3.0×10^4	N	N/A	N/							

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   D. ESCA
   E. GS/MS
2. EXPECTED TEST SUCCESS
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

* Summation of S-2-5, S-2-6 and S-2-7.

1. Based on Level 2 leachate study of sample S-2-6.

N.D. Not Detected.

N.R. Not Required on Level 2.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE* µg/m^3 (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
57. CHLORINE	Chloride Ion, Cl^-	N	1.3×10^6	N	2.6×10^3	N	N.R.						
	Hypochlorite, ClO^-	N	N	N	N	N							
	Chlorite, ClO_2^-	N	N	N	N	N							
	Chlorate, ClO_3	N	N	N	N	N							
	Chlorine Dioxide, ClO_2	N	N	N	N	N							
	Carbohyl Chloride (phosgene), $COCl_2$	4.0×10^2	6.0×10^3	N	N/A	N/A							
	Hydrogen Chloride, HCl	7.0×10^3	1.1×10^5	N	N/A	N/A							
58. BROMINE	Bromide Ion, Br^-	N	N	N	N	N	N.R.						
	Bromide Ion, Br^-	N	N	N	N	N							
	Hydrogen Bromide, HBr	1.0×10^4	1.5×10^5	N	N/A	N/A							
59. IODINE	Iodide Ion, I^-	N	N	N	N	N	N.R.						
60. SCANDIUM	Scandium, Sc	5.3×10^4	8.0×10	N	1.6×10^{-2}	N	N.R.						
	Scandium Ion, Sc^{+3}	5.3×10^4	8.0×10	N	1.6×10^{-2}	N							
61. YTTRIUM	Yttrium Ion, Y^{+3}	1.0×10^3	1.5×10^4	N	3.0×10^1	N	N.R.						
62. TITANIUM	Titanium, Ti	6.0×10^3	9.0×10^4	8.2×10^2 (as $Ti[SO_4]_2$)	1.8×10^2	1.6×10							
	Titanous, Ti^{+3} (as Ti)	6.0×10^3	9.0×10^4	8.2×10^2	1.8×10^2	1.6×10							
	Titanic, Ti^{+4} (as Ti)	6.0×10^3	9.0×10^4	8.2×10^2	1.8×10^2	1.6×10							
	Titanium Dioxide, TiO_2 (as Ti)	6.0×10^3	9.0×10^4	8.2×10^2	1.8×10^2	1.6×10	N.D.						
63. ZIRCONIUM	Zirconium Ion, Zr^{+4}	5.0×10^3	7.5×10^4	N	1.5×10^1	N	2.0x10	Does Not Exceed Mate					
	Zirconium Dioxide, ZrO_2 (as Zr)	5.0×10^3	7.5×10^4	N	1.5×10^1	N							
64. HAFNIUM	Hafnium Ion, Hf^{+4}	5.0×10^2	7.5×10^4	N	1.5×10	N	N.R.						
65. VANADIUM	Vanadium, V	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}	2.6×10^3	Exceeds Mate					
	Elemental Vanadium, V	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadic, V^{+3} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadyl, Vo^{+2} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Orthovanadate, VO_4^{-4} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}	Present Based on Compound Data						

TABLE KEY:

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   3. UNKNOWN

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   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

* Summation of S-2-5, S-2-6 and S-2-7.

1. Based on Level 2 leachate study of S-2-6.

N.D. Not Detected.

N.R. Not Required on Level 2.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE* µg/m³ (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Metavanadate, VO_3^- (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadylic, VO^{+3} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Monoxide, VO (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Trioxide, V_2O_3 (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}	Present	Based on Compound Data					
	Vanadium Tetraoxide, V_2O_4, (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}	Present	Based on Compound Data					
	Vanadium Pentoxide, V_2O_5 (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}	Present	Based on Compound Data					
	Vanadium Carbide, VC (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Monosulfide, VS (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Nitride, VN (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadyl Sulfate, $VOSO_4 \cdot 5H_2O$ (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}	Present	Based on Compound Data					
66. NIOBIUM	Niobus, Nb^{+3}	2.2×10^4	3.3×10^5	N	6.5×10^2	N	N.R.						
	Niobic, Nb^{+5}	2.2×10^4	3.3×10^5	N	6.5×10^2	N							
	Niobium Oxides, NbO, Nb_2O_5 (as Nb)	2.2×10^4	3.3×10^3	N	6.5×10^2	N							
67. TANTALUM	Tantalum Ion, Ta^{+5}	5.0×10^3	7.5×10^4	N	1.5×10^2	N	N.R.						
68. CHROMIUM	Chromium, Cr	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	8.34×10^3	Exceeds Mate					
	Chromous, Cr^{+2} (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	3.9×10	Exceeds Mate - See Note 1					
	Chromic, Cr^{+3} (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	3.9×10	Exceeds Mate - See Note 1					
	Chromates, CrO_4^{-2} (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	Present	Based on Compound Data					
	Chromites, $Cr_2O_4^{-2}$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	Present	Based on Compound Data					
	Dichromates, $Cr_2O_7^{-2}$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromium Carbonyl, $Cr(CO)_6$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromium Sulfide, Cr_2S_3	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	Present	Based on Compound Data					
	Chromic Oxide, Cr_2O_3 (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	Present	Based on Compound Data					
	Chromite Mineral, FeO Cr_2O_3 (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							

TABLE KEY

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   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

* Summation of S-2-5, S-2-6 and S-2-7.

1. Based on Level 2 leachate study of S-2-6.

N.D. Not Detected.

N.R. Not Required on Level 2.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE* µg/m³ (ppm)² µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD¹	TEST EXPECTATIONS²	TEST COST³	SAMPLE ALIQUOT⁴
	Hydrous Chromium Phosphate, $CrPO_4 . XH_2O$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Iron Chromate, $FeCrO_4$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
69. MOLYBDEN	Molybdenum, Mo	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1	N.R.						
	Molybdenous, Mo^{+2}	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdic, Mo^{+3}	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdate, MoO_4^{-2} (as Mo)	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdenum Sulfide, MoS_2 (as Mo)	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdenum Trioxide, MoO_3 (as Mo)	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
70. TUNGSTEN	Tungsten, W	1.0×10^3	1.5×10^4	N	3.0×10^1	N	N.R.						
	Tungsten Ions, W^{+2}, W^{+4}, W^{+5}, W^{+6}, WO_4^{-2}	N	N	N	N	N							
	Tungsten Disulfide, WS_2 (as W)	1.0×10^3	1.5×10^4	N	3.0×10^1	N							
	Wolframite Mineral, $FeWO_4 \cdot MnWO_4$ (as W)	1.0×10^3	1.5×10^4	N	3.0×10^1	N							
71. MANGANESE	Manganese, Mn	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganous, Mn^{+2}	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}	1.3×10^2	Does Not Exceed Mate					
	Manganic, Mn^{+3}	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}	1.3×10^2						
	Permanganate, MnO_4^- (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganous Oxide, MnO (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganese Dioxide, MnO_2 (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganese Carbonate, $McCO_3$ (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganous Sulfate, $MnSO_4$ (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganese Sulfide, MnS_2 (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
72. IRON	Iron Carbonyls, $Fe(CO)_5$, $Fe(CO)_9$, $FE_3(CO)_{12}$	7.0×10^2	1.1×10^4	N	2.1×10^1	N							
	Ferrous, Fe^{+2}	1.0×10^3	1.5×10^3	2.5×10^2	3.0×10	5.0×10^{-1}	5.6×10^2	Does Not Exceed Mate					
	Ferric, Fe^{+3}	1.0×10^3	1.5×10^3	2.5×10^2	3.0×10	5.0×10^{-1}	5.6×10^2	Does Not Exceed Mate					
	Ferrous Oxide, FeO	5.0×10^3	7.5×10^4	N	1.5×10^2	N	N.D.						

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   D. ESCA
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2. EXPECTED TEST SUCCESS:
   1. HIGH
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   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

* Summation of -2-5, S-2-6 and S-2-7.

1. Based on Level 2 leachate study of sample S-2-6.

N.D. Not Detected.

N.R. Not Required on Level 2.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	SAMPLE* $\mu g/m^3$ (ppm) $\mu g/l$	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Magnetite, $FeO \cdot Fe_2O_3$	9.3 x 10^3	6.2 x 10^3	N	3.8 x 10^1	N							
	Ferrocyanide, $Fe(CN)_6^{-4}$	N	N	N	N	N							
	Ferricyanide, $Fe(CN)_6^{-3}$	N	N	N	N	N							
	Ferric Oxide, Fe_2O_3	N	N	N	N	N	Present Based on Compound Data						
	Ferric Hydroxide (hydrated) $Fe_2O_3 \cdot XH_2O$	N	N	N	N	N							
	Iron Sulfides, FeS, Fe_2S_3	N	N	N	N	N							
	Pyrite, FeS_2	N	N	>1.0 x 10^5	N	2.0 x 10^2							
	Potassium Iron Silicate, $KFeSi_2O_6$	N	N	N	N	N							
73. RUTHENIUM	Ruthenium Ion, Ru^{+3}	N	N	N	N	N	N.R.						
74. COBALT	Cobalt, Co	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}							
	Cobaltous, Co^{+2}	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}	N.D.						
	Cobaltic, Co^{+3}	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}	N.D.						
	Cobaltous Carbonate, hydrated, $CoCO_3 \cdot H_2O$ (as Co)	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}							
	Cobalt Carbide, Co_3C (as Co)	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}							
	Cobalt Sulfides, CoS, Co_2S_3 (as Co)	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}							
	Cobalt Arsenic Sulfide, CoAsS (as Co)	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}							
	Cobalt Arsenide, $CoAs_2$ (as Co)	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}							
	Cobalt Carbonyl, $Co(CO)_4$ (as Co)	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}							
	Cobaltous Oxide, CoO (as Co)	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}							
	Cobaltous Hydroxide, $Co(OH)_2$ (as Co)	5.0 x 10^1	7.5 x 10^2	2.5 x 10^2	1.5 x 10	5.0 x 10^{-1}							
75. RHODIUM	Rhodium Ion, Rh^{+3}	1.0 x 10	1.5 x 10^1	N	3.0 x 10^{-2}	N	N.D.						
76. NICKEL	Nickelous, Ni^{+2}	1.5 x 10^1	2.3 x 10^2	1.0 x 10^1	4.5 x 10^{-1}	2.0 x 10^{-2}	N.D.	See Note 1					
	Nickelic, Ni^{+3}	1.5 x 10^1	2.3 x 10^2	1.0 x 10^1	4.5 x 10^{-1}	2.0 x 10^{-2}	N.D.	See Note 1					
	Nickelous Sulfide, NiS (as Ni)	1.5 x 10^1	2.3 x 10^2	1.0 x 10^1	4.5 x 10^{-1}	2.0 x 10^{-2}							
	Nickel Arsenide, NiAs (as Ni)	1.5 x 10^1	2.3 x 10^2	1.0 x 10^1	4.5 x 10^{-1}	2.0 x 10^{-2}							

TABLE KEY

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

* Summation of S-2-5, S-2-6 and S-2-7.

1. Based on Level 2 leachate study of sample S-2-6.

N.D. Not Detected.

N.R. Not Required on Level 2.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE* μg/m³ (ppm) μg/l	RATIO $\frac{\text{SAMPLE}}{\text{MATE}}$	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Nickel Oxide, NiO (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Antimonide, NiSb (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Arsenic Sulfide, NiAsS (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Carbonyl, $Ni(CO)_4$	4.3×10^1	6.5×10^2	1.0×10^1 (as Ni)	1.0×10	2.0×10^{-3}							
77. PLATINUM	Elemental Platinum, Pt	2.0×10	3.0×10^1	N	6.0×10^{-2}	N	N.R.						
78. COPPER	Copper	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Cuprous, Cu^+	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}	4.6x10	Does Not Exceed Mate					
	Cupric, Cu^{+2}	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}	4.6x10	Does Not Exceed Mate					
	Copper Fluoride, CuF_2 (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Copper Oxides, CuO, Cu_2O (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-5}							
	Copper Sulfate, $CuSO_4$ (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Copper Sulfides, CuS, Cu_2S (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Copper Carbonate, $CuCO_3$ (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Malachite Mineral, $CuCO_3 \cdot Cu(OH)_2$ (as Cu)	2.0×10^2	5.0×10^3	5.0×10^1	1.0×10^1	1.0×10^{-1}							
	Chalcopyrite Mineral, $CuFeS_2$	N	N	N	N	N							
79. SILVER	Silver, Ag	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	3.9×10^2		Exceeds Mate				
	Silver Ion, Ag^+ (as Ag)	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Silver Chloride, AgCl (as Ag)	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Silver Cyanide, AgCN (as Ag)	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Silver Sulfide, Ag_2S (as Ag)	1.0×10^1	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	Present Based on Compound Data						
80. GOLD	Elemental Gold	N	N	N	N	N	N.R.						
81. ZINC	Zinc, Zn	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}	6.6×10^3		Exceeds Mate				
	Elemental Zinc, Zn	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							
	Zinc Ion, Zn^{+2}	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							
	Zinc Oxide, ZnO (as Zn)	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}	Present Based on Compound Data						

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

* Summation of S-2-5, S-2-6 and S-2-7.

1. Based on Level 2 leachate study of sample S-2-6.

N.D. Not Detected.

N.R. Not Required on Level 2.

Table 3-13. Level 2 Data on FBC Emission Samples (Continued)

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	SAMPLE* $\mu g/m^3$ (ppm) $\mu g/l$	RATIO $\frac{\text{SAMPLE}}{\text{MATE}}$	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Zinc Sulfate, $ZnSO_4$ (as Zn)	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}	Present Based on Compound Data						
	Zinc Sulfide, ZnS (as Zn)	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}	Present Based on Compound Data						
82. CADMIUM	Cadmium, Cd	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}	5.0		Does not exceed mate				
	Elemental Cadmium, Cd	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
	Cadmium Ion, Cd^{+2}	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
	Cadmium Sulfide, CdS (as Cd)	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
	Cadmium Oxide, CdO (as Cd)	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
83. MERCURY	Mercury, Hg	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}	9.3×10^2		Exceeds Mate				
	Elemental Mercury, Hg	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercurous, Hg_2^{++}	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercuric, Hg^{++}	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercuric Sulfide, HgS	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercuric Chloride, $HgCl_2$	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
84. CERIUM	Dysprosium, Dy (Dy^{+3})	9.3×10^3	2.3×10^5	N	4.6×10^2	N	N.R.						
	Cerium, Ce (Ce^{+3}, Ce^{+4}, Ce_2O_3)	3.7×10^4	5.5×10^5	N	1.1×10^3	N							
	Praseodymium, Pr (Pr^{+3})	5.1×10^4	7.7×10^5	N	1.5×10^3	N							
	Samarium, Sm (Sm^{+3})	5.3×10^4	7.9×10^5	N	1.6×10^3	N							
	Lanthanum, La	1.1×10^5	1.7×10^6	N	3.4×10^3	N							
	Neodymium, Nd (Nd^{+3})	N	N	N	N	N							
85. URANIUM	Uranium, U (U^{+6})	9.0×10	6.0×10^4	5.0×10^2	1.2 x 102	1.0×10	N.D.						
86. THORIUM	Thorium, Th (Th^{+4})	4.2×10^2	6.3×10^3	N	1.3×10	N	N.D.						

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

* Summation of S-2-5, S-2-6 and S-2-7.

[1] Based on Level 2 leachate study of sample S-2-6.

N.D. Not Detected.

N.R. Not Required on Level 2.

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials

Level 2 Leachate Studies of Overflow Bed Materials*

CATEGORY	COMPOUND	MATE AIR μg/m^3 (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m^3 (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
27. LITHIUM	Li	2.2×10	3.3×10^2	3.8×10^2	7.0×10^{-1}	7.5×10^{-1}	5.8×10^2		Exceeds Mate				
	Li$^+$	2.2×10	3.3×10^2	3.8×10^2									
	LiF (as Li)	2.2×10	3.3×10^2	3.8×10^2									
	Li_2CO_3 (as Li)	2.2×10	3.3×10^2	3.8×10^2									
	LiH	2.5×10	3.8×10^2	N									
28. SODIUM	Na$^+$	5.3×10^4	8.0×10^5	N	1.6×10^3	N	1.7×10^4		Does Not Exceed Mate				
	NaOH	2.0×10^3	3.0×10^4	N	6.0×10	N							
29. POTASSIUM	KOH	2.0×10^3	3.0×10^4	N	6.0×10	N	7.2×10^3		Does Not Exceed Mate				
	K	N	N	N	N	N							
	K$^+$ (as K)	N	N	2.3×10^4	N	4.6×10							
30. RUBIDIUM	Rb^{+1}	1.21×10^5	1.82×10^6	N	3.64×10^3	N	N.D.						
31. CESIUM	CS^{+1}	8.19×10^4	1.23×10^6	N	2.46×10^3	N	N.D.						
32. BERYLLIUM	Be	2.0	3.0×10	5.5×10	6.0×10^{-2}	1.1×10^{-1}	N.D.						
	Be^{++}	2.0	3.0×10	5.5×10	6.0×10^{-2}	1.1×10^{-1}							
	BeO (as Be)												
	$BeO-Al_2O_3-SiO_2$ (as Be)	2.0	3.0×10	5.5×10	6.0×10^{-2}	1.1×10^{-1}							
33. MAGNESIUM	Magnesium, Mg	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2	1.4×3		Does Not Exceed Mate				
	Magnesium Ion, Mg^{++}	6.01×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Magnesium Oxide, MgO	1.01×10^4	1.5×10^5	1.0×10^5	3.0×10^2	2.0×10^2							
	Magnesium Fluoride, MgF_2 (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Magnesium Sulfate, $MgSO_4$ (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Magnesite, $MgCO_3$ (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Dolomite, $MgCO_3$-$CaCO_3$ (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
	Asbestos (as Mg)	6.0×10^3	9.0×10^4	8.7×10^4	1.8×10^2	1.7×10^2							
34. CALCIUM	Calcium Ion, Ca^{++}	1.6×10^4	2.4×10^5	1.6×10^4	4.8×10^2	3.2×10	1.3×10^6		Exceeds Mate				
	Calcium Fluoride, CaF_2	N	N	N	N	N							
	Calcium Carbonate, $CaCO_3$	N	N	N	N	N							
	Calcium Sulfate, $CaSO_4$	N	N	N	N	N							
	Dolomite, $MgCO_3$-$CaCO_3$	N	N	N	N	N							

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m³ (ppm) μg/l	RATIO SAMPLE / MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
35. STRONTIUM	Strontium	3.1×10^3	4.6×10^4	N	9.2×10	N	3.9×10^2	Does Not Exceed Mate					
	Strontium Ion, Sr^{++} (as Sr)	3.1×10^3	4.6×10^4	N	9.2×10	N							
	Strontium Fluoride, SrF_2 (as Sr)	3.1×10^3	4.6×10^4	N	9.2×10	N							
	Strontium Sulfate, $SrSO_4$ (as Sr)	3.1×10^3	4.6×10^4	N	9.2×10	N							
36. BARIUM	Barium, Ba	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0	N.D.						
	Barium Ion, Ba^{++} (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Sulfide, BaS (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Thiocarbonate, $BaCS_3$ (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Fluoride, BaF_2 (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
	Barium Carbonate, $BaCO_3$ (as Ba)	5.0×10^2	5.0×10^3	8.5×10^3	1.0×10	5.0							
	Barium Sulfate, $BaSO_4$ (as Ba)	5.0×10^2	5.0×10^3	2.5×10^3	1.0×10	5.0							
37. BORON	Boron, B	3.1×10^3	4.7×10^4	2.5×10^4	9.3×10	5.0×10	3.1×10^4	Does Not Exceed Mate					
	Borate, BO_3 (as B)	3.1×10^3	4.7×10^4	2.5×10^4	9.3×10	5.0×10							
	Metaborate, BO_2- (as B)	3.1×10^3	4.7×10^4	2.5×10^4	9.3×10	5.0×10							
	Boron Oxide, B_2O_3	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
38. ALUMINUM	Aluminum, Al	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.01	7.4×10^3	Does Not Exceed Mate					
	Aluminum Ion, Al^{+++}	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	N							
	Bauxite, $Al_2O_3 \cdot 3H_2O$ (as Al)	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.0							
	Hydrated Aluminum Silicate (as Al)	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.0							
	Alums $[M\,Al\,(SO_4)_2] \cdot (H_2O)_x$ (as Al)	5.2×10^3	8.0×10^4	1.0×10^3	1.6×10^2	2.0							
	Aluminum Oxide, Al_2O_3	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
39. GALLIUM	Gallium, Ga	5.0×10^3	7.4×10^4	N	1.5×10^2	N	N.D.						
	Elemental Species, Ga	5.0×10^3	7.4×10^4	N	1.5×10^2	N							
	Gallous, Ga^{+1} (as Ga)	5.0×10^3	7.4×10^4	N	1.5×10^2	N							

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR μg/m^3 (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m^3 (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Gallic, Ga^{+3} (as Ga)	5.0×10^3	7.4×10^4	N	1.5×10^2	N							
	Gallium Sesquioxide, Ga_2O_3 (as Ga)	5.0×10^3	7.4×10^4	N	1.5×10^2	N							
40. INDIUM	Indium, In	1.0×10^2	1.5×10^3	N	3.0	N	N.D.						
	Indium Ion, In^{+3}	1.0×10^2	1.5×10^3	N	3.0	N							
41. THALLIUM	Thallium, Tl	1.0×10^2	1.5×10^3	N	3.0	N	N.D.						
	Thallous, Tl^{+1}	1.0×10^2	1.5×10^3	N	3.0	N							
	Thallic, Tl^{+3}	1.0×10^2	1.5×10^3	N	3.0	N							
42. CARBON	Elemental Carbon	3.5×10^3	5.3×10^4	N	1.6×10^2	N	N.D.						
	Coal	N	N	N	N	N							
	Carbide, C-	N	N	N	N	N							
	Carbonate, CO_3^{-2}	N	N	N	N	N							
	Bicarbonate, HCO_3	N	N	N	N	N							
	Carbonyl, CO=	N	N	N	N	N							
	Carbon Monoxide	4.0×10^3 (35)	6.0×10^5	6.0×10	N/A	N/A							
	Carbon Dioxide	9.0×10^6 (5000)	N	N	N/A	N/A							
43. SILICON	Silane, SiH_4	7.0×10^2	1.1×10^4	N	N	2.1×10	2.6×10^5			Exceeds Mate			
	Silicon, Si	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
	Orthosilicate, SiO_4^{-2}	N	N	N	N	N							
	Metasilicate, SiO_3^{-2}	N	N	N	N	N							
	Silicon Dioxide, SiO_2	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
	Silicon Disulfide, SiS_2	N	N	N	N	N							
	Silicon Carbide, SiC	1.0×10^4	1.5×10^5	N	3.0×10^2	N							
44. GERMANIUM	Germanium, Ge	5.6×10^2	8.4×10^3	N	1.7×10	N	N.D.						
	Germanous, Ge^{+2} (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germanic, Ge^{+4} (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germanous Sulfide, GeS (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germanic Sulfice, GeS_2 (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germane, GeH_4 (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							
	Germanium Oxide, GeO_2 (as Ge)	5.6×10^2	8.4×10^3	N	1.7×10	N							

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY:

1. TEST METHOD
   1. STANDARD
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   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE µg/m³ (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
45. TIN	Tin Oxide, SnO_2	1.0×10^4	1.5×10^5	N	3.0	N	N.D.						
	Tin, Sn	N	N	N	N	N							
	Stannous, Sn^{+2}	N	N	N	N	N							
	Stannic, Sn^{+4}	N	N	N	N	N							
46. LEAD	Lead, Pb	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}	2.3×10^2		Does Not Exceed Mate				
	Elemental Lead, Pb	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Plumbous, Pb^{+2}	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Plumbic, Pb^{+4} (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Monoxide, PbO (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Sulfate, $PbSO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Sulfate, Pbs (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Carbonate, $PbCO_3$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Phosphate, $Pb_3(PO_4)_2$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Chromate, $PbCrO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Molybdate, $PbMoO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Lead Arsenate, $PbHAsO_4$ (as Pb)	1.5×10^2	2.5×10^2	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
47. NITROGEN	Hydrazine	1.5×10^2 (.1)	2.3	N	4.5	N	N.D.						
	Alkali Cyanides, NaCN, KCN	5.0×10^3	5.0×10^2	2.5×10	1.0	5.0×10^{-2}							
	Nitric Acid, HNO_3	5.0×10^3	7.5×10^4	4.5×10^2	1.5×10^3	9.0×10^{-1}							
	Nitrogen Oxides, N_2O, NO_2, N_2O_4, N_2O_3, N_2O_5	9.0×10^3	1.4×10^5	N	N/A	N/A							
	Hydrogen Cyanide, HCN	1.1×10^4 (10)	5.0×10^2	2.5×10	1.0	5.0×10^{-2}							
	Ammonia, NH_3	1.8×10^4 (25)	2.5×10^3	5.0×10	5.0	1.0×10^{-1}							
	Cyanogen, C_2N_2	2.0×10^4	1.0×10^3	2.5×10	2.0	5.0×10^{-2}							
	Nitride, $N^=$	N	N	N	N	N							
	Nitrate, NO_3^-	N	N	N	N	N							
	Nitrite, NO_2^-	N	N	N	N	N							
	Ammonium, NH_4^+	N	N	N	N	N							

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY:

1. TEST METHOD
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   A. AAS
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   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	SAMPLE $\mu g/m^3$ (ppm) $\mu g/l$	RATIO $\frac{\text{SAMPLE}}{\text{MATE}}$	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
48. PHOSPHORUS	Phosphorus, P	1.0×10^{2}	1.5×10^{4}	5.0×10^{-1}	3.0×10	1.0×10^{-3}	N.D.						
	Phosphite, PO_3^{-3} (as P)	1.0×10^{2}	1.5×10^{4}	5.0×10^{-1}	3.0×10	1.0×10^{-3}							
	Biphosphate, $H_2PO_4^-$ (as P)	1.0×10^{2}	1.5×10^{4}	5.0×10^{-1}	3.0×10	1.0×10^{-3}							
	Phosphine, PH_3	4.0×10^{2} (0.3)	6.0×10^{3}	N	N/A	N/A							
	Phosphoric Acid, H_3PO_4	1.0×10^{3}	1.5×10^{4}	4.5×10^{3}	3.0×10	9.0							
	Phosphorus Pentasulfide	1.0×10^{3}	1.5×10^{4}	N	3.0×10	N							
	Phosphate, PO_4^{-3}	N	N	N	N	N							
49. ARSENIC	Arsenic, As	2.0×10	2.5×10^{2}	5.0×10^{1}	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Metallic Arsenic	2.0×10	2.5×10^{2}	5.0×10^{1}	5.0×10^{-1}	1.0×10^{-1}							
	Arsenous, As^{+3}	2.0×10	2.5×10^{2}	5.0×10^{1}	5.0×10^{-1}	1.0×10^{-1}							
	Arsenic, As^{+5}	2.0×10	2.5×10^{2}	5.0×10^{1}	5.0×10^{-1}	1.0×10^{-1}							
	Arsenate, AsO_4^{-3} (as As)	2.0×10	2.5×10^{2}	5.0×10^{1}	5.0×10^{-1}	1.0×10^{-1}							
	Arsenite, AsO_3^{-3} (as As)	2.0×10	2.5×10^{2}	5.0×10^{1}	5.0×10^{-1}	1.0×10^{-1}							
	Arsenide, As^{-3} (as As)	2.0×10	2.5×10^{2}	5.0×10^{1}	5.0×10^{-1}	1.0×10^{-1}							
	Arsine, AsH_3	2.0×10	2.5×10^{2}	5.0×10^{1}	5.0×10^{-1}	1.0×10^{-1}							
	Arsenic Trioxide, As_2O_3	2.0×10	2.5×10^{2}	5.0×10^{1}	5.0×10^{-1}	1.0×10^{-1}							
50. ANTIMONY	Antimony Trioxide, Sb_2O_3	5.0×10^{1}	7.5×10^{2}	2.0×10^{2} (as Sb)	1.5×10	4.0×10^{-1} (as Sb)	N.D.						
	Antimony Metal, Sb	5.0×10^{2}	7.5×10^{3}	2.0×10^{2}	1.5×10^{1}	4.0×10^{-1}							
	Antimonous, (stibnous) Sb^{+3}	5.0×10^{2}	7.5×10^{3}	2.0×10^{2}	1.5×10^{1}	4.0×10^{-1}							
	Antimonic (stibnic) Sb^{+5}	5.0×10^{2}	7.5×10^{3}	2.0×10^{2}	1.5×10^{1}	4.0×10^{-1}							
	Stibine, SbH_3 (as Sb)	5.0×10^{2}	7.5×10^{3}	2.0×10^{2}	1.5×10^{1}	4.0×10^{-1}							
	Antimonous Sulfide, Sb_2S_3	5.0×10^{2}	7.5×10^{3}	2.0×10^{2}	1.5×10^{1}	4.0×10^{-1}							
	Antimony, Sb	5.0×10^{2}	7.5×10^{3}	2.0×10^{2}	1.5×10^{1}	4.0×10^{-1}							
51. BISMUTH	Bismuth, Bi	4.1×10^{2}	6.1×10^{3}	N	1.2×10^{1}	N	N.D.						
	Elemental Bismuth, Bi	4.1×10^{2}	6.1×10^{3}	N	1.2×10^{1}	N							
	Bismuthous, Bi^{+3} (as Bi)	4.1×10^{2}	6.1×10^{3}	N	1.2×10^{1}	N							
	Bismuthic, Bi^{+5} (as Bi)	4.1×10^{2}	6.1×10^{3}	N	1.2×10^{1}	N							

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GS/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE µg/m^3 (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD^1	TEST EXPEC-TATIONS^2	TEST COST^3	SAMPLE ALIQUOT^4
52. OXYGEN	Ozone, O_3	2.0×10^2 (0.1)	N/A	N/A	N/A	N/A	N.D.						
53. SULFUR	Rhombic Sulfur, S_8	N	N	N	N	N	N.D.						
	Sulfide, S^{-2}	N	N	N	N	N							
	Sulfate, SO_4^{-2}	N	N	N	N	N							
	Sulfite, SO_3^{-2}	N	N	N	N	N							
	Thiocyanate, SCN^-	N	N	N	N	N							
	Sulfur Trioxide, SO_3	N	N	N	N	N							
	Sulfuric Acid, H_2SO_4	1.0×10^3	1.5×10^4	4.5×10^2	3.0×10^1	9.0×10^2							
	Sulfur Dioxides, SO_2	1.3×10^4	2.0×10^5	N	4.0×10^2	N							
	Hydrogen Sulfide, H_2S	1.5×10^4 (10)	2.3×10^4	1.0×10^1	N/A	N/A							
	Carbon Disulfide, CS_2	6.0×10^4 (20)	9.0×10^5	1.0×10^4	N/A	N/A							
	Carbonyl Sulfide, COS	4.4×10^5	N/A	N/A	N/A	N/A							
54. SELENIUM	Selenium, Se	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}	N.D.						
	Elemental Selenium, Se	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Selenide, Se^{-2}	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Selenites, SeO_3^{-2} (as Se)	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Selenates, SeO_4^{-2} (as Se)	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Hydrogen Selenide, H_2Se	2.0×10^2 (.05)	5.0×10^1 (as Se)	2.5×10^1 (as Se)	1.0×10^{-1} (as Se)	5.0×10^{-2} (as Se)							
	Carbon Diselenide, CSe_2 (as Se)	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
	Selenium Dioxide, SeO_2 (as Se)	2.0×10^2	5.0×10^1	2.5×10^1	1.0×10^{-1}	5.0×10^{-2}							
55. TELLURIUM	Tellurium, Te	1.0×10^2	1.5×10^3	N	3.0×10	N	N.D.						
	Telluride, Te^{-2}	1.0×10^2	1.5×10^3	N	3.0×10	N							
	Tellurite, TeO_3^{-2} (as Te)	1.0×10^2	1.5×10^3	N	3.0×10	N							
	Tellurate, TeO_4 (as Te)	1.0×10^2	1.5×10^3	N	3.0×10	N							
56. FLUORIDE	Fluoride Ion, F^-	2.5×10^3	3.8×10^4	N	7.5×10^1	N	N.D.						
	Hydrogen Fluoride, HF	2.0×10^3	3.0×10^4	N	N/A	N/							

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY:

1. TEST METHOD
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   A. AAS
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   D. ESCA
   E. GS/MS
2. EXPECTED TEST SUCCESS
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   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR $\mu g/m^3$ (ppm)	MATE WATER $\mu g/l$ HEALTH	MATE WATER $\mu g/l$ ECOLOGY	MATE LAND $\mu g/g$ HEALTH	MATE LAND $\mu g/g$ ECOLOGY	SAMPLE $\mu g/m^3$ (ppm) $\mu g/l$	RATIO $\frac{\text{SAMPLE}}{\text{MATE}}$	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPEC-TATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
57. CHLORINE	Chloride Ion, Cl^-	N	1.3×10^6	N	2.6×10^3	N	N.D.						
	Hypochlorite, ClO^-	N	N	N	N	N							
	Chlorite, ClO_2^-	N	N	N	N	N							
	Chlorate, ClO_3	N	N	N	N	N							
	Chlorine Dioxide, ClO_2	N	N	N	N	N							
	Carbonyl Chloride (phosgene), $COCl_2$	4.0×10^2	6.0×10^3	N	N/A	N/A							
	Hydrogen Chloride, HCl	7.0×10^3	1.1×10^5	N	N/A	N/A							
58. BROMINE	Bromide Ion, Br^-	N	N	N	N	N	N.D.						
	Bromide Ion, Br^-	N	N	N	N	N							
	Hydrogen Bromide, HBr	1.0×10^4	1.5×10^5	N	N/A	N/A							
59. IODINE	Iodide Ion, I^-	N	N	N	N	N	N.D.						
60. SCANDIUM	Scandium, Sc	5.3×10^4	8.0×10	N	1.6×10^{-2}	N	N.D.						
	Scandium Ion, Sc^{+3}	5.3×10^4	8.0×10	N	1.6×10^{-2}	N							
61. YTTRIUM	Yttrium Ion, Y^{+3}	1.0×10^3	1.5×10^4	N	3.0×10^1	N	N.D.						
62. TITANIUM	Titanium, Ti	6.0×10^3	9.0×10^4	8.2×10^2 (as $Ti[SO_4]_2$)	1.8×10^2	1.6×10	N.D.						
	Titanous, Ti^{+3} (as Ti)	6.0×10^3	9.0×10^4	8.2×10^2	1.8×10^2	1.6×10							
	Titanic, Ti^{+4} (as Ti)	6.0×10^3	9.0×10^4	8.2×10^2	1.8×10^2	1.6×10							
	Titanium Dioxide, TiO_2 (as Ti)	6.0×10^3	9.0×10^4	8.2×10^2	1.8×10^2	1.6×10							
63. ZIRCONIUM	Zirconium Ion, Zr^{+4}	5.0×10^3	7.5×10^4	N	1.5×10^1	N	N.D.						
	Zirconium Dioxide, ZrO_2 (as Zr)	5.0×10^3	7.5×10^4	N	1.5×10^1	N							
64. HAFNIUM	Hafnium Ion, Hf^{+4}	5.0×10^2	7.5×10^4	N	1.5×10	N	N.D.						
65. VANADIUM	Vanadium, V	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}	N.D.						
	Elemental Vanadium, V	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadic, V^{+3} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadyl, VO^{+2} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Orthovanadate, VO_4^{-4} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected.

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
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   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR μg/m³ (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m³ (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD¹	TEST EXPECTATIONS²	TEST COST³	SAMPLE ALIQUOT⁴
	Metavanadate, VO_3^- (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadylic, VO^{+3} (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Monoxide, VO (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Trioxide, V_2O_3 (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Tetraoxide, V_2O_4, (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Pentoxide, V_2O_5 (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Carbide, VC (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Monosulfide, VS (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadium Nitride, VN (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
	Vanadyl Sulfate, $VOSO_4 \cdot 5H_2O$ (as V)	5.0×10^2	2.5×10^3	1.5×10^2	5.0×10	3.0×10^{-1}							
66. NIOBIUM	Niobous, Nb^{+3}	2.2×10^4	3.3×10^5	N	6.5×10^2	N							
	Niobic, Nb^{+5}	2.2×10^4	3.3×10^5	N	6.5×10^2	N	N.D.						
	Niobium Oxides, NbO, Nb_2O_5 (as Nb)	2.2×10^4	3.3×10^3	N	6.5×10^2	N							
67. TANTALUM	Tantalum Ion, Ta^{+5}	5.0×10^3	7.5×10^4	N	1.5×10^2	N							
68. CHROMIUM	Chromium, Cr	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	N.D.						
	Chromous, Cr^{+2} (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}	N.D.						
	Chromic, Cr^{+3} (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromates, CrO_4^{-2} (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromites, $Cr_2O_4^{-2}$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Dichromates, $Cr_2O_7^{-2}$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromium Carbonyl, $Cr(CO)_6$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromium Sulfide, Cr_2S_3	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromic Oxide, Cr_2O_3 (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Chromite Mineral, FeO Cr_2O_3 (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							

*Only sample 5-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
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   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE µg/m³ (ppm)² µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD¹	TEST EXPEC-TATIONS²	TEST COST³	SAMPLE ALIQUOT⁴
	Hydrous Chromium Phosphate, $CrPO_4$ XH_2O (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
	Iron Chromate, $FeCrO_4$ (as Cr)	1.0×10	2.5×10^2	2.5×10^2	5.0×10^{-1}	5.0×10^{-1}							
69. MOLYBDEN	Molybdenum, Mo	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1	6.0×10		Does Not Exceed Mate				
	Molybdenous, Mo^{+2}	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdic, Mo^{+3}	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdate, MoO_4^{-2} (as Mo)	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdenum Sulfide, MoS_2 (as Mo)	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
	Molybdenum Trioxide, MoO_3 (as Mo)	5.0×10^3	7.5×10^4	7.0×10^3	1.5×10^2	1.4×10^1							
70. TUNGSTEN	Tungsten, W	1.0×10^3	1.5×10^4	N	3.0×10^1	N	N.D.						
	Tungsten Ions, W^{+2}, W^{+4}, W^{+5}, W^{+6}, WO_4^{-2}	N	N	N	N	N							
	Tungsten Disulfide, WS_2 (as W)	1.0×10^3	1.5×10^4	N	3.0×10^1	N							
	Wolframite Mineral, $FeWO_4 \cdot MnWO_4$ (as W)	1.0×10^3	1.5×10^4	N	3.0×10^1	N							
71. MANGANESE	Manganese, Mn	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}	N.D.						
	Manganous, Mn^{+2}	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganic, Mn^{+3}	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Permanganate, MnO_4^- (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganous Oxide, MnO (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganese Dioxide, MnO_2 (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganese Carbonate, $McCO_3$ (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganous Sulfate, $MnSO_4$ (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
	Manganese Sulfide, MnS_2 (as Mn)	5.0×10^3	2.5×10^2	1.0×10^2	5.0×10^{-1}	2.0×10^{-1}							
72. IRON	Iron Carbonyls, $Fe(CO)_5$, $Fe(CO)_9$, $FE_3(CO)_{12}$	7.0×10^2	1.1×10^4	N	2.1×10^1	N	8.0×10^2		Does Not Exceed Mate				
	Ferrous, Fe^{+2}	1.0×10^3	1.5×10^3	2.5×10^2	3.0×10	5.0×10^{-1}							
	Ferric, Fe^{+3}	1.0×10^3	1.5×10^3	2.5×10^2	3.0×10	5.0×10^{-1}							
	Ferrous Oxide, FeO	5.0×10^3	7.5×10^4	N	1.5×10^2	N							

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected

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   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

		Level 2 Leachate Studies of Overflow Bed Material*											
CATEGORY	COMPOUND	MATE AIR μg/m^3 (ppm)	MATE WATER μg/l HEALTH	MATE WATER μg/l ECOLOGY	MATE LAND μg/g HEALTH	MATE LAND μg/g ECOLOGY	SAMPLE μg/m^3 (ppm) μg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD^1	TEST EXPEC-TATIONS^2	TEST COST^3	SAMPLE ALIQUOT^4
	Magnetite, $FeO \cdot Fe_2O_3$	9.3×10^3	6.2×10^3	N	3.8×10^1	N							
	Ferrocyanide, $Fe(CN)_6^{-4}$	N	N	N	N	N							
	Ferricyanide, $Fe(CN)_6^{-3}$	N	N	N	N	N							
	Ferric Oxide, Fe_2O_3	N	N	N	N	N							
	Ferric Hydroxide (hydrated) $Fe_2O_3 \cdot XH_2O$	N	N	N	N	N							
	Iron Sulfides, FeS, Fe_2S_3	N	N	N	N	N							
	Pyrite, FeS_2	N	N	$>1.0 \times 10^5$	N	2.0×10^2							
	Potassium Iron Silicate, $KFeSi_2O_6$	N	N	N	N	N							
73. RUTHENIUM	Ruthenium Ion, Ru^{+3}	N	N	N	N	N							
74. COBALT	Cobalt, Co	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}	N.D.						
	Cobaltous, Co^{+2}	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}	N.D.						
	Cobaltic, Co^{+3}	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobaltous Carbonate, hydrated, $CoCO_3 \cdot H_2O$ (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Carbide, Co_3C (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Sulfides, CoS, Co_2S_3 (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Arsenic Sulfide, CoAsS (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Arsenide, $CoAs_2$ (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobalt Carbonyl, $Co(CO)_4$ (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobaltous Oxide, CoO (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
	Cobaltous Hydroxide, $Co(OH)_2$ (as Co)	5.0×10^1	7.5×10^2	2.5×10^2	1.5×10	5.0×10^{-1}							
75. RHODIUM	Rhodium Ion, Rh^{+3}	1.0×10	1.5×10^1	N	3.0×10^{-2}	N							
76. NICKEL	Nickelous, Ni^{+2}	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}	N.D.						
	Nickelic, Ni^{+3}	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}	1.7×10^2	Does Not Exceed Mate					
	Nickelous Sulfide, NiS (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Arsenide, NiAs (as Ni)	1.5×10^1	2.3×10^2	1.0×10^1	4.5×10^{-1}	2.0×10^{-2}							

*Only sample, S-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY

1. TEST METHOD
   1. STANDARD
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   3. UNKNOWN

   A. AAS
   B. XRD
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   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR µg/m³ (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE µg/m³ (ppm) µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Nickel Oxide, NiO (as Ni)	1.5×10^{1}	2.3×10^{2}	1.0×10^{1}	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Antimonide, NiSb (as Ni)	1.5×10^{1}	2.3×10^{2}	1.0×10^{1}	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Arsenic Sulfide, NiAsS (as Ni)	1.5×10^{1}	2.3×10^{2}	1.0×10^{1}	4.5×10^{-1}	2.0×10^{-2}							
	Nickel Carbonyl, $Ni(CO)_4$	4.3×10^{1}	6.5×10^{2}	1.0×10^{1} (as Ni)	1.0×10	2.0×10^{-3}							
77. PLATINUM	Elemental Platinum, Pt	2.0×10	3.0×10^{1}	N	6.0×10^{-2}	N	N.D.						
78. COPPER	Copper	2.0×10^{2}	5.0×10^{3}	5.0×10^{1}	1.0×10^{1}	1.0×10^{-1}	1.4×10				Does Not Exceed Mate		
	Cuprous, Cu^{+}	2.0×10^{2}	5.0×10^{3}	5.0×10^{1}	1.0×10^{1}	1.0×10^{-1}							
	Cupric, Cu^{+2}	2.0×10^{2}	5.0×10^{3}	5.0×10^{1}	1.0×10^{1}	1.0×10^{-1}							
	Copper Fluoride, CuF_2 (as Cu)	2.0×10^{2}	5.0×10^{3}	5.0×10^{1}	1.0×10^{1}	1.0×10^{-1}							
	Copper Oxides, CuO, Cu_2O (as Cu)	2.0×10^{2}	5.0×10^{3}	5.0×10^{1}	1.0×10^{1}	1.0×10^{-5}							
	Copper Sulfate, $CuSO_4$ (as Cu)	2.0×10^{2}	5.0×10^{3}	5.0×10^{1}	1.0×10^{1}	1.0×10^{-1}							
	Copper Sulfides, CuS, Cu_2S (as Cu)	2.0×10^{2}	5.0×10^{3}	5.0×10^{1}	1.0×10^{1}	1.0×10^{-1}							
	Copper Carbonate, $CuCO_3$ (as Cu)	2.0×10^{2}	5.0×10^{3}	5.0×10^{1}	1.0×10^{1}	1.0×10^{-1}							
	Malachite Mineral, $CuCO_3 \cdot Cu(OH)_2$ (as Cu)	2.0×10^{2}	5.0×10^{3}	5.0×10^{1}	1.0×10^{1}	1.0×10^{-1}							
	Chalcopyrite Mineral, $CuFeS_2$	N	N	N	N	N							
79. SILVER	Silver, Ag	1.0×10^{1}	2.5×10^{2}	5.0×10	5.0×10^{-1}	1.0×10^{-1}	N.D.						
	Silver Ion, Ag^{+} (as Ag)	1.0×10^{1}	2.5×10^{2}	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Silver Chloride, AgCl (as Ag)	1.0×10^{1}	2.5×10^{2}	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Silver Cyanide, AgCN (as Ag)	1.0×10^{1}	2.5×10^{2}	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
	Silver Sulfide, Ag_2S (as Ag)	1.0×10^{1}	2.5×10^{2}	5.0×10	5.0×10^{-1}	1.0×10^{-1}							
80. GOLD	Elemental Gold	N	N	N	N	N	N.D.						
81. ZINC	Zinc, Zn	4.0×10^{3}	2.5×10^{4}	1.0×10^{2}	5.0×10^{1}	2.0×10^{-1}	2.2×10^{2}				Does Not Exceed Mate		
	Elemental Zinc, Zn	4.0×10^{3}	2.5×10^{4}	1.0×10^{2}	5.0×10^{1}	2.0×10^{-1}							
	Zinc Ion, Zn^{+2}	4.0×10^{3}	2.5×10^{4}	1.0×10^{2}	5.0×10^{1}	2.0×10^{-1}							
	Zinc Oxide, ZnO (as Zn)	4.0×10^{3}	2.5×10^{4}	1.0×10^{2}	5.0×10^{1}	2.0×10^{-1}							

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY:

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    2. MODERATE
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    1. ADEQUATE
    2. MARGINAL
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    4. RESAMPLE

Table 3-14. Level 2 Leachate Studies of Overflow Bed Materials (Continued)

Level 2 Leachate Studies of Overflow Bed Material*

CATEGORY	COMPOUND	MATE AIR µg/m^3 (ppm)	MATE WATER µg/l HEALTH	MATE WATER µg/l ECOLOGY	MATE LAND µg/g HEALTH	MATE LAND µg/g ECOLOGY	SAMPLE µg/m^3 ~~(ppm)~~ µg/l	RATIO SAMPLE/MATE	LEVEL 2 REQUIRED Y=YES N=NO	TEST METHOD[1]	TEST EXPECTATIONS[2]	TEST COST[3]	SAMPLE ALIQUOT[4]
	Zinc Sulfate, $ZnSO_4$ (as Zn)	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							
	Zinc Sulfide, ZnS (as Zn)	4.0×10^3	2.5×10^4	1.0×10^2	5.0×10^1	2.0×10^{-1}							
82. CADMIUM	Cadmium, Cd	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}	N.D.						
	Elemental Cadmium, Cd	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
	Cadmium Ion, Cd^{+2}	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
	Cadmium Sulfide, CdS (as Cd)	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
	Cadmium Oxide, CdO (as Cd)	1.0×10^1	5.0×10^1	1.0×10	1.0×10^{-1}	2.0×10^{-3}							
83. MERCURY	Mercury, Hg	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}	N.D.						
	Elemental Mercury, Hg	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercurous, Hg_2^{++}	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercuric, Hg^{++}	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercuric Sulfide, HgS	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
	Mercuric Chloride, $HgCl_2$	5.0×10^1	1.0×10^1	2.5×10^2	2.0×10^{-2}	5.0×10^{-1}							
84. CERIUM	Dysprosium, Dy (Dy^{+3})	9.3×10^3	2.3×10^5	N	4.6×10^2	N	N.D.						
	Cerium, Ce (Ce^{+3}, Ce^{+4}, Ce_2O_3)	3.7×10^4	5.5×10^5	N	1.1×10^3	N							
	Praseodymium, Pr (Pr^{+3})	5.1×10^4	7.7×10^5	N	1.5×10^3	N							
	Samarium, Sm (Sm^{+3})	5.3×10^4	7.9×10^5	N	1.6×10^3	N							
	Lanthanum, La	1.1×10^5	1.7×10^6	N	3.4×10^3	N							
	Neodymium, Nd (Nd^{+3})	N	N	N	N	N							
85. URANIUM	Uranium, U (U^{+6})	9.0×10	6.0×10^4	5.0×10^2	1.2×102	1.0×10	N.D.						
86. THORIUM	Thorium, Th (Th^{+4})	4.2×10^2	6.3×10^3	N	1.3×10	N	N.D.						

*Only sample S-2-3, summation of acidic and basic. N.D. Not Detected

TABLE KEY:

1. TEST METHOD
   1. STANDARD
   2. DEVELOPMENTAL
   3. UNKNOWN

   A. AAS
   B. XRD
   C. WET CHEMICAL
   D. ESCA
   E. GC/MS
2. EXPECTED TEST SUCCESS:
   1. HIGH
   2. MODERATE
   3. UNKNOWN
3. TEST COST
   1. REASONABLE
   2. MODERATE
   3. HIGH
4. SAMPLE ALIQUOT
   1. ADEQUATE
   2. MARGINAL
   3. INADEQUATE
   4. RESAMPLE

4. LEVEL 2 ORGANIC ANALYSIS OF THE FLUIDIZED BED COMBUSTOR PARTICULATES

The Level 2 organic analysis conducted on the FBC particulate samples followed the plan outlined in the reference text and depicted here as Figure 4-1. The Level 2 analysis technique employed for compound identification was gas chromatography/mass spectrometry (GC/MS).

Level 1 organic analysis was also conducted and these data are reported in Appendix E. Closure to the Level 1 data was sought throughout the conductance of the Level 2 and can be evaluated through the summation Table I presented in the Abstract, page iii.

4.1 SAMPLE PREPARATION AND ALLOCATION PLAN

All the FBC particulate samples were extracted in methylene chloride according to both the Level 1 protocol and the Level 2 organic approach. Because both Level 1 and Level 2 analysis had to be conducted with such a limited quantity of sample, the allocation plan depicted in Figure 4-2 was designed to provide a sufficient quantity of material for each analytical phase. The quantities of particulates extracted are given in Section 2.0 on Table 2-4, Sample Inventory and General Disbursement Plan.

4.1.1 Instrument Employed in Sections 4.2, 4.3 and 4.4

A Finnigan 4000 GC/MS with microprocessor controlled gas chromatograph, one second scan time, high sensitivity, high resolution, switchable dual CI/EI source, and capillary GC capability was employed. This instrument is interfaced to an INCOS 2000 data system. The data acquisition system consists of a Nova III computer, high density dual disk storage, a Versetec printer/plotter and a CRT terminal. The data system features a foreground/background processing capability which allows for simultaneous data acquisition and processing of mass spectrometer data. Spectra may be displayed from previously recorded files or from the file actually being acquired. The data system incorporates the EPA spectral file together with the NIH reference file for library searching.

4.2 VOLATILE ORGANIC LEVEL 2 ANALYSIS

Figure 4-1 is the overall organic Level 2 plan. The FBC samples were prepared as SASS train particulate samples (details are given in Appendix E), e.g., a cyclone catch. An initial gas chromatography/mass

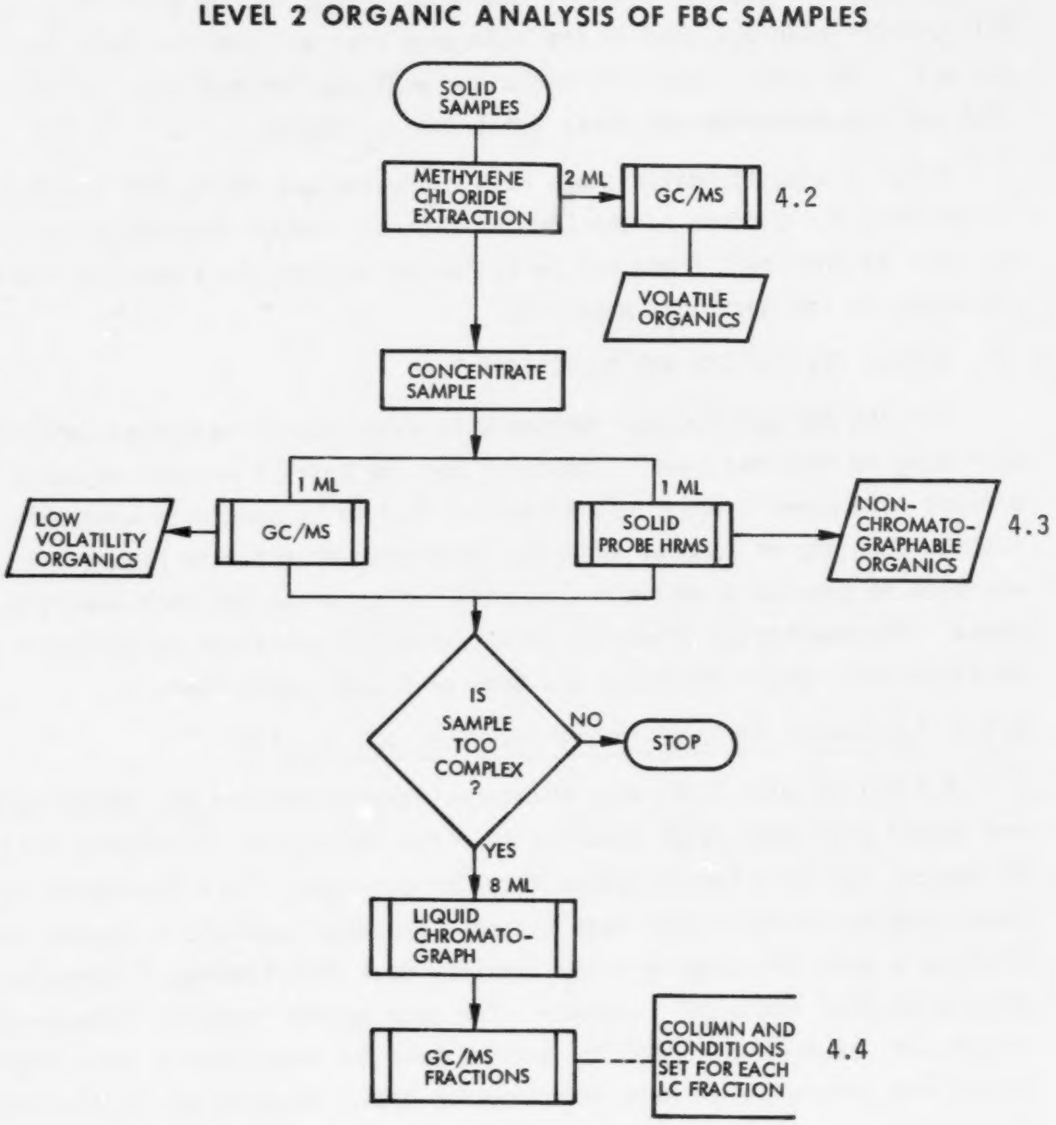
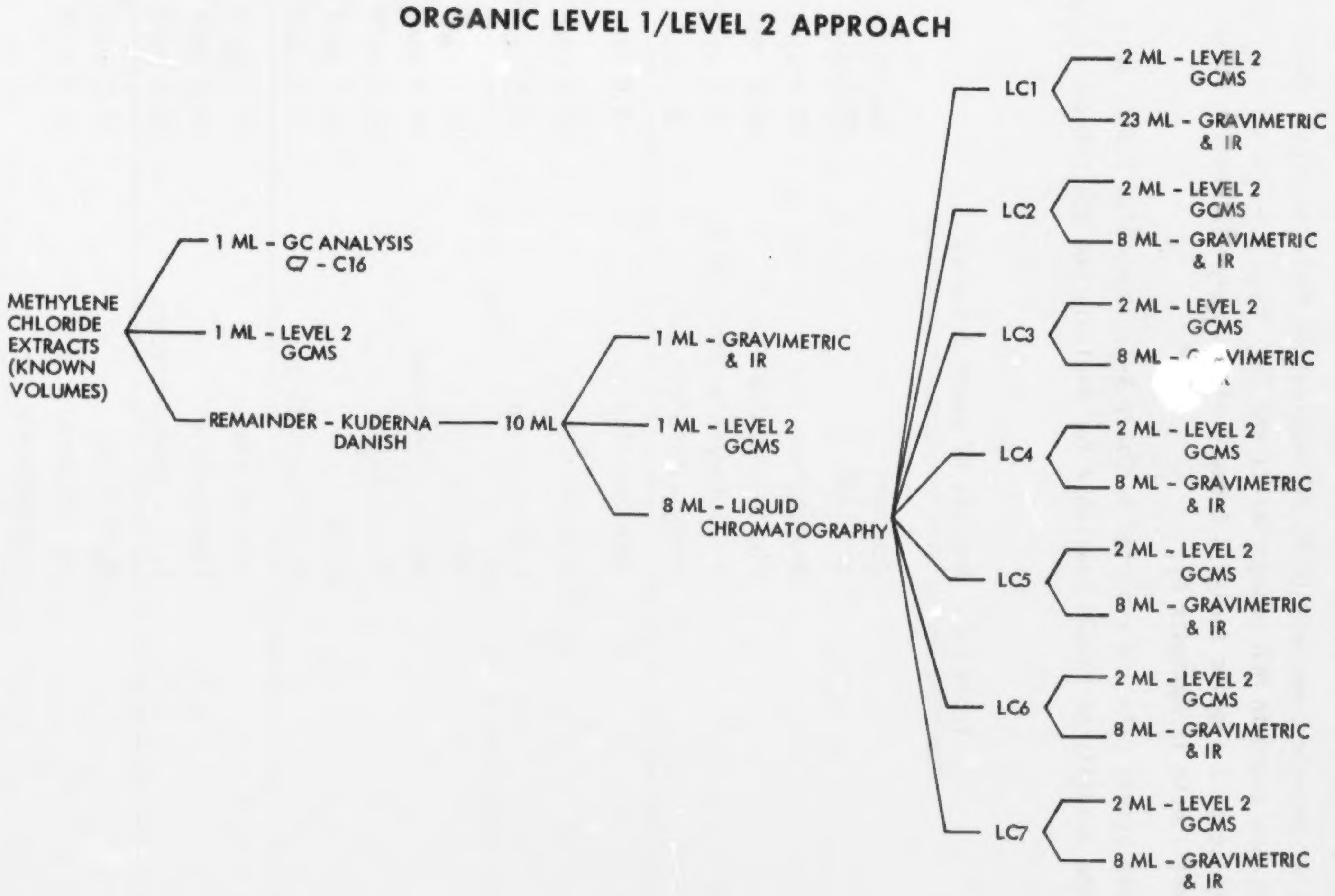

LEVEL 2 ORGANIC ANALYSIS OF FBC SAMPLES
SOLID SAMPLES
METHYLENE CHLORIDE EXTRACTION
2 ML
GC/MS
4.2
VOLATILE ORGANICS
CONCENTRATE SAMPLE
1 ML
1 ML
LOW VOLATILITY ORGANICS
GC/MS
SOLID PROBE HRMS
NON-CHROMATO-GRAPHABLE ORGANICS
4.3
IS SAMPLE TOO COMPLEX ?
NO
STOP
YES
8 ML
LIQUID CHROMATO-GRAPH
GC/MS FRACTIONS
COLUMN AND CONDITIONS SET FOR EACH LC FRACTION
4.4

Figure 4-1. Level 2 Organic Analysis Scheme.



ORGANIC LEVEL 1/LEVEL 2 APPROACH

METHYLENE CHLORIDE EXTRACTS (KNOWN VOLUMES)
1 ML - GC ANALYSIS C7 - C16
1 ML - LEVEL 2 GCMS
REMAINDER - KUDERNA DANISH
10 ML
1 ML - GRAVIMETRIC & IR
1 ML - LEVEL 2 GCMS
8 ML - LIQUID CHROMATOGRAPHY
LC1
2 ML - LEVEL 2 GCMS
23 ML - GRAVIMETRIC & IR
LC2
2 ML - LEVEL 2 GCMS
8 ML - GRAVIMETRIC & IR
LC3
2 ML - LEVEL 2 GCMS
8 ML - [illegible]VIMETRIC
LC4
2 ML - LEVEL 2 GCMS
8 ML - GRAVIMETRIC & IR
LC5
2 ML - LEVEL 2 GCMS
8 ML - GRAVIMETRIC & IR
LC6
2 ML - LEVEL 2 GCMS
8 ML - GRAVIMETRIC & IR
LC7
2 ML - LEVEL 2 GCMS
8 ML - GRAVIMETRIC & IR

Figure 4-2. Level 1 and Level 2 Sample Allocation Plan

spectrometry (GC/MS) analysis was conducted on the concentrated (but not to dryness) aliquot from the methylene chloride ($MeCl_2$). This was conducted as a survey analysis for volatiles and identified and quantified some of the Polynuclear Organic Compounds (POM) of interest in these samples. These compounds are found in MEG categories 21 and 22. Sample S-2-2 was not subjected to Level 2 organic analysis because of its very low organic content (see Level 1 data in Appendix E).

These survey data are reported in Table 4-1. Detection limits vary due to the quantity of sample available for analysis and the emission rate factors:

Table 4-1. Results of Level 2 Survey
Analysis for Polynuclear Organic Compounds

Sample Number	Compound Identity	Compound Quantity
S-2-1	Naphthalene	22.9 μg/g*
	Dimethylnaphthalene	49.8 μg/g*
	Phenanthrene or Anthracene	17.4 μg/g*
	Methylanthracene	22.4 μg/g*
S-2-2	None Detected	<1.0 μg/g*
S-2-3	None Detected	<19.9 $\mu g/M^3$
S-2-4	None Detected	<0.2 $\mu g/M^3$
S-2-5	Phenanthrene	117.0 $\mu g/M^3$
	Methyl Anthracene	117.0 $\mu g/M^3$
	Fluoranthene	117.0 $\mu g/M^3$
	Pyrene	34.7 $\mu g/M^3$
	Benzofluoranthene	19.3 $\mu g/M^3$
S-2-6	Phenanthrene	37.6 $\mu g/M^3$
	Fluoranthene	89.3 $\mu g/M^3$
	1, 2 - Benzanthracene	28.2 $\mu g/M^3$
S-2-7	Naphthalene	15.0 $\mu g/M^3$
	Phenanthrene or Diphenylacetylene	18.0 $\mu g/M^3$

* No Rate Data

4.3 LOW RESOLUTION MASS SPECTROMETRIC IDENTIFICATION OF NON-CHROMATOGRAPHABLE COMPONENTS

The organic extracts of each FBC sample were analysed by direct inlet mass spectrometry. This was conducted to identify the nonvolatile, non-chromatographable organic species and verify that no significant species were being overlooked by just conducting GC/MS analysis. The results of these analyses are reported in Table 4-2. In the case of all the emitted particulates this residue was very small and would not be a significant contributor to the overall organic emissions.

Table 4-2. Low Resolution Mass Spectrometric Analysis of Non-Volatile Components of the FBC Samples

Sample Number	Mass Spectra Identified	Comments
S-2-1	Free Sulfur, Trans-1-2-3 Trimethyl -4 Propenyl - Naphthalene, 1,2-Dimethyl-4-Benzylbenzene,2-Methyl Anthracene, 1-Methylphenanthrene Triphenylbenzene, 1,2,4,-5-Tetra-isopropylbenzene and others.	Very complex spectra of high molecular weight aliphatic and substituted aromatic compounds, all of which have not been identified.
S-2-3	1-Octadecene, 1-Heptadecene, 1-Hexadecene, 1-Dodecene	Very small sample residue with only a trace of hydrocarbons and a trace of phthalate ester.
S-2-4	1-Octadecene, 1-Hexadecene	Very small sample residue with only a trace of hydrocarbons and a trace of phthalate ester.
S-2-5	2-Phenyl Naphthalene, 1,6-Diphenylpenta-1-4-Diene-3-one, 2-Phenyl Naphthalene	Small sample residue with hydrocarbons, phtalates and a series of high molecular weight substituted aromatics.
S-2-6	1-Octadecene	Small sample residue with hydrocarbons, phthalates and a trace of high molecular weight aromatics.
S-2-7	1-Octadecene	Small residue with hydrocarbons, phthalates and a trace of high molecular weight aromatics.

4.4 GC/MS ANALYSIS OF LIQUID CHROMATOGRAPHIC FRACTIONS

A Level 2 GC/MS survey analysis was also conducted on combinations of the liquid chromatographic (LC) fractions. This was performed on an OV-17 column using a heating rate of 10°C/min and heating from 50°C to 300°C. Non-volatile, non-chromatographable materials would not be analyzed by this technique. However, this was conducted as a preliminary screening technique to identify and quantify the predominate volatile organic compounds in the LC fractions and elucidate the complexity of each fraction. Fraction 8 of each sample was not submitted to this survey analysis. Table 4-3 records the results of this preliminary survey. Compounds listed as "unknown" were sought during the next analytical phase, chemical ionization/gas chromatography/mass spectrometry.

Table 4-3. Level 2 Survey Analysis of Liquid Chromatographic Fractions

Sample Identification	Liquid Chromatographic Fraction	Compound Identity	Compound Quantity
S-2-1	1	16 Carbon Hydrocarbon	Present <16 µg/g*
		17 Carbon Hydrocarbon	16 µg/g*
		18 Carbon Hydrocarbon	16 µg/g*
		19 Carbon Hydrocarbon	16 µg/g*
		20 Carbon Hydrocarbon	Present <16 µg/g*
		Unknown	190 µg/g*
S-2-3	1	16 Carbon Hydrocarbon	Present <300 µg/M^3
		17 Carbon Hydrocarbon	Present <300 µg/M^3
		18 Carbon Hydrocarbon	Present <300 µg/M^3
		19 Carbon Hydrocarbon	Present <300 µg/M^3

Table 4-3. Level 2 Survey Analysis of (Cont'd)

Sample Identification	Liquid Chromatographic Fraction	Compound Identity	Compound Quantity
		20 Carbon Hydrocarbon	Present <300 μg/M^3
		Unknown	470 μg/M^3
S-2-4	1	16 Carbon Hydrocarbon	Present <16 μg/M^3
		17 Carbon Hydrocarbon	Present <16 μg/M^3
		18 Carbon Hydrocarbon	Present <16 μg/M^3
		19 Carbon Hydrocarbon	Present <16 μg/M^3
		20 Carbon Hydrocarbon	Present <16 μg/M^3
		Unknown	Present <16 μg/M^3
S-2-5	1	16 Carbon Hydrocarbon	Present <20 μg/M^3
		17 Carbon Hydrocarbon	20 μg/M^3
		18 Carbon Hydrocarbon	Present <20 μg/M^3
		19 Carbon Hydrocarbon	Present <20 μg/M^3
		20 Carbon Hydrocarbon	Present <20 μg/M^3
		Unknown	Present 20 μg/M^3
S-2-6	1	16 Carbon Hydrocarbon	Present <300 μg/M^3
		17 Carbon Hydrocarbon	Present <300 μg/M^3
		18 Carbon Hydrocarbon	Present <300 μg/M^3
		19 Carbon Hydrocarbon	Present <300 μg/M^3
		20 Carbon Hydrocarbon	Present <300 μg/M^3
		Unknown	Present <300 μg/M^3
S-2-7	1	None Detected	<50 μg/M^3

Table 4-3. Level 2 Survey Analysis of Liquid Chromatographic Fractions (Cont'd)

Sample Identification	Liquid Chromatographic Fraction	Compound Identity	Compound Quantity	
S-2-1	2 and 3		Unknown	80 µg/g*
		15 Carbon Hydrocarbon	Present	<6 µg/g*
		16 Carbon Hydrocarbon	Present	<6 µg/g*
		17 Carbon Hydrocarbon	Present	<6 µg/g*
		18 Carbon Hydrocarbon	Present	<6 µg/g*
		19 Carbon Hydrocarbon	Present	<6 µg/g*
		20 Carbon Hydrocarbon	Present	<6 µg/g*
		21 Carbon Hydrocarbon	Present	<6 µg/g*
		Phthalate Ester	Present	<6 µg/g*
		Unknown 2		<6 µg/g*
S-2-3	2 and 3		Unknown/ Present	<120 $\mu g/M^3$
		15 Carbon Hydrocarbon		310 $\mu g/M^3$
		16 Carbon Hydrocarbon		560 $\mu g/M^3$
		17 Carbon Hydrocarbon		1,180 $\mu g/M^3$
		18 Carbon Hydrocarbon		1,620 $\mu g/M^3$
		19 Carbon Hydrocarbon		680 $\mu g/M^3$
		20 Carbon Hydrocarbon		560 $\mu g/M^3$
		21 Carbon Hydrocarbon		310 $\mu g/M^3$
		Phthalate Ester		1,120 $\mu g/M^3$
		Unknown		120 $\mu g/M^3$

---

*No Rate Data

Table 4-3. Level 2 Survey Analysis of Liquid Chromatographic Fractions (Con't)

Sample Identification	Liquid Chromatographic Fraction	Compound Identify	Compound Quantity
S-2-4	2 and 3		Unknown Present < 7 $\mu g/M^3$
		15 Carbon Hydrocarbon	Present < 7 $\mu g/M^3$
		16 Carbon Hydrocarbon	Present < 7 $\mu g/M^3$
		17 Carbon Hydrocarbon	30 $\mu g/M^3$
		18 Carbon Hydrocarbon	23 $\mu g/M^3$
		19 Carbon Hydrocarbon	Present < 7 $\mu g/M^3$
		20 Carbon Hydrocarbon	Present < 7 $\mu g/M^3$
		21 Carbon Hydrocarbon	Present < 7 $\mu g/M^3$
		Phthalate Ester	16 $\mu g/M^3$
		Unknown	2 Present < 7 $\mu g/M^3$
S-2-5	2 and 3		Unknown/ Present <10 $\mu g/M^3$
		15 Carbon Hydrocarbon	10 $\mu g/M^3$
		16 Carbon Hydrocarbon	20 $\mu g/M^3$
		17 Carbon Hydrocarbon	30 $\mu g/M^3$
		18 Carbon Hydrocarbon	50 $\mu g/M^3$
		19 Carbon Hydrocarbon	30 $\mu g/M^3$
		20 Carbon Hydrocarbon	20 $\mu g/M^3$
		21 Carbon Hydrocarbon	10 $\mu g/M^3$

Table 4-3. Level 2 Survey Analysis of
Liquid Chromatographic Fractions (Con't)

Sample Identification	Liquid Chromatographic Fraction	Compound Identify	Compound Quantity
S-2-6	2 and 3		Unknown/ Present <120 μg/M^3
		15 Carbon Hydrocarbon	Present <120 μg/M^3
		16 Carbon Hydrocarbon	Present <120 μg/M^3
		17 Carbon Hydrocarbon	180 μg/M^3
		18 Carbon Hydrocarbon	180 μg/M^3
		19 Carbon Hydrocarbon	120 μg/M^3
		20 Carbon Hydrocarbon	60 μg/M^3
		21 Carbon Hydrocarbon	60 μg/M^3
		Phthalate Ester	Present <120 μg/M^3
		Unknown	180 μg/M^3
S-2-7	2 and 3	None Detected	< 50 μg/M^3
S-2-1	4 and 5	Phthalate Ester	25 μg/g*
		Unknown	50 μg/g*
		Unknown	60 μg/g*
S-2-3	4 and 5	Phthalate Ester	1,120 μg/M^3
		Unknown	870 μg/M^3
		Unknown	1,180 μg/M^3
S-2-4	4 and 5	Phthalate Ester	50 μg/M^3
		Unknown	80 μg/M^3
		Unknown	1/2 Present <7 μg/M^3

*No Rate Data

Table 4-3. Level 2 Survey Analysis of Liquid Chromatographic Fractions (Con't)

Sample Identification	Liquid Chromatographic Fraction	Compound Identify		Compound Quantity
S-2-5	4 and 5	Phthalate Ester	Present	<10 μg/M^3
		Unknown		550 μg/M^3
		Unknown	Present	<10 μg/M^3
S-2-6	4 and 5	Phthalate Ester		2,120 μg/M^3
		Unknown		5,500 μg/M^3
		Unknown	Present	<120 μg/M^3
S-2-7	4 and 5	None Detected		<50 μg/M^3
S-2-1	6 and 7	Propyl Phthalate	Present	<6 μg/g*
		Unknown		220 μg/g*
		Unknown	Present	<6 μg/g*
		Phthalate Ester	Present	<6 μg/g*
S-2-3	6 and 7	Propyl Phthalate		4,100 μg/M^3
		Unknown		1,300 μg/M^3
		Unknown		1,740 μg/M^3
		Phthalate Ester		120 μg/M^3
S-2-4	6 and 7	Propyl Phthalate	Present	<7 μg/M^3
		Unknown	Present	<7 μg/M^3
		Unknown	Present	<7 μg/M^3
		Phthalate Ester		410 μg/M^3
S-2-5	6 and 7	Propyl Phthalate	Present	<10 μg/M^3
		Unknown		120 μg/M^3
		Unknown		470 μg/M^3
		Phthalate Ester		620 μg/M^3

*No Rate Data

Table 4-3. Level 2 Survey Analysis of Liquid Chromatographic Fractions (Con't)

Sample Identification	Liquid Chromatographic Fraction	Compound Identify	Compound Quantity
S-2-6	6 and 7	Propyl Phthalate	Present <120 $\mu g/M^3$
		Unknown	Present <120 $\mu g/M^3$
		Unknown	Present <120 $\mu g/M^3$
		Phthalate Ester	Present <120 $\mu g/M^3$
S-2-7	6 and 7	Unknown	280 $\mu g/M^3$

*No Rate Data

The materials identified by this analysis were not complex and all belonged to MEG category 1, alkanes greater than C9, or category 8 Esters, phthalates.

4.5 CHEMICAL IONIZATION/GAS CHROMATOGRAPHY/MASS SPECTROMETRY

GC/MS analysis using chemical ionization was performed on those samples with peaks unidentified by the impact (EI) ionization technique. Chemical ionization GC/MS was used to obtain molecular weight information which could be used in identifying the unknowns. The samples were analyzed according to the following procedure.

4.5.1 Procedure and Results

The samples were analyzed on a Dupont Model 321 GC/MS. A six-foot glass column containing 3% OV-17 on Chromosorb W-HP was used. The column oven was programmed from 50°C to 300°C at 8 degrees per minute. The ion source was heated to 200°C. Methane was used as the reagent gas. Helium at 30cc/min was used as the chromatograph carrier gas. The mass range from 60 to 450 AMU was scanned every two seconds in a continuous cyclic recording. The INCOS data system was used to acquire, store, and reduce the data.

In general, the use of GC/MS with chemical ionization did very little to supply additional information which could be used in identifying the unknowns found in the EI data. Most, if not all, the compounds which were not identifiable from the EI data appeared to be hydrocarbons. Hydrocarbon compounds are not amenable to chemical ionization because they are not ionized efficiently.

An additional shortcoming was that the GC parameters could not be duplicated using the du Pont 321 GC-MS. Therefore there was little basis for comparing even the chromatograms from the two analyses.

The information obtainable from the subject analysis is summarized in Table 4-4. The table shows that, with the exception of one compound, the samples do not contain similar components. The one compound that is common to four samples had an apparent molecular weight of 176 and has a CI spectra suggestive of a phthalate ester. However, no phthalates exist with a molecular weight of 176. The identification of this compound remains unknown. The remaining compounds that were detected in these samples had compounds that were either tentatively identified as phthalate esters or hydrocarbons with molecular weights as shown in the table.

Table 4-4. Results of Chemical Ionization GC/MS Analysis

SAMPLE / LC Fraction	MW176	COMPOUND[1]		2nd Hydrocarbon	Phthalate Ester	Hydrocarbon MW 394
		Butyl Phthalate	1st Hydrocarbon MW 332			
S-2-1/1				X		
S-2-1	X					
S-2-3/2&3	X	X	X		X	
S-2-3/6&7	X					
S-2-7/6&7	X				X	X

---

[1] See text for further compound information.

Sample S-2-1 LC/2 and 3 was shown, from the EI data, to contain only one significant compound. The chromatogram obtained from running the same sample with chemical ionization was rather complex. Computerized data enhancement was undertaken in order to obtain usable spectral information. There are approximately 8 to 10 major peaks along with 10 to 15 additional peaks where additional information may have been able to be obtained. Five compounds with molecular weights of 184, 178, 192, 192, and 208 caused substantial peaks. The compound with molecular weight of 208 is very likely the methyl-ethyl ester of phthalic anhydride.

It is concluded that analyzing these samples by GC/MS, using chemical ionization, was of little or no value in identifying the compounds which could not be identified from the EI spectra.

4.6 CONCLUSIONS BASED ON LEVEL 2 ORGANIC ANALYSIS

Compounds identified by this Level 2 organic analysis scheme are summarized as follows:

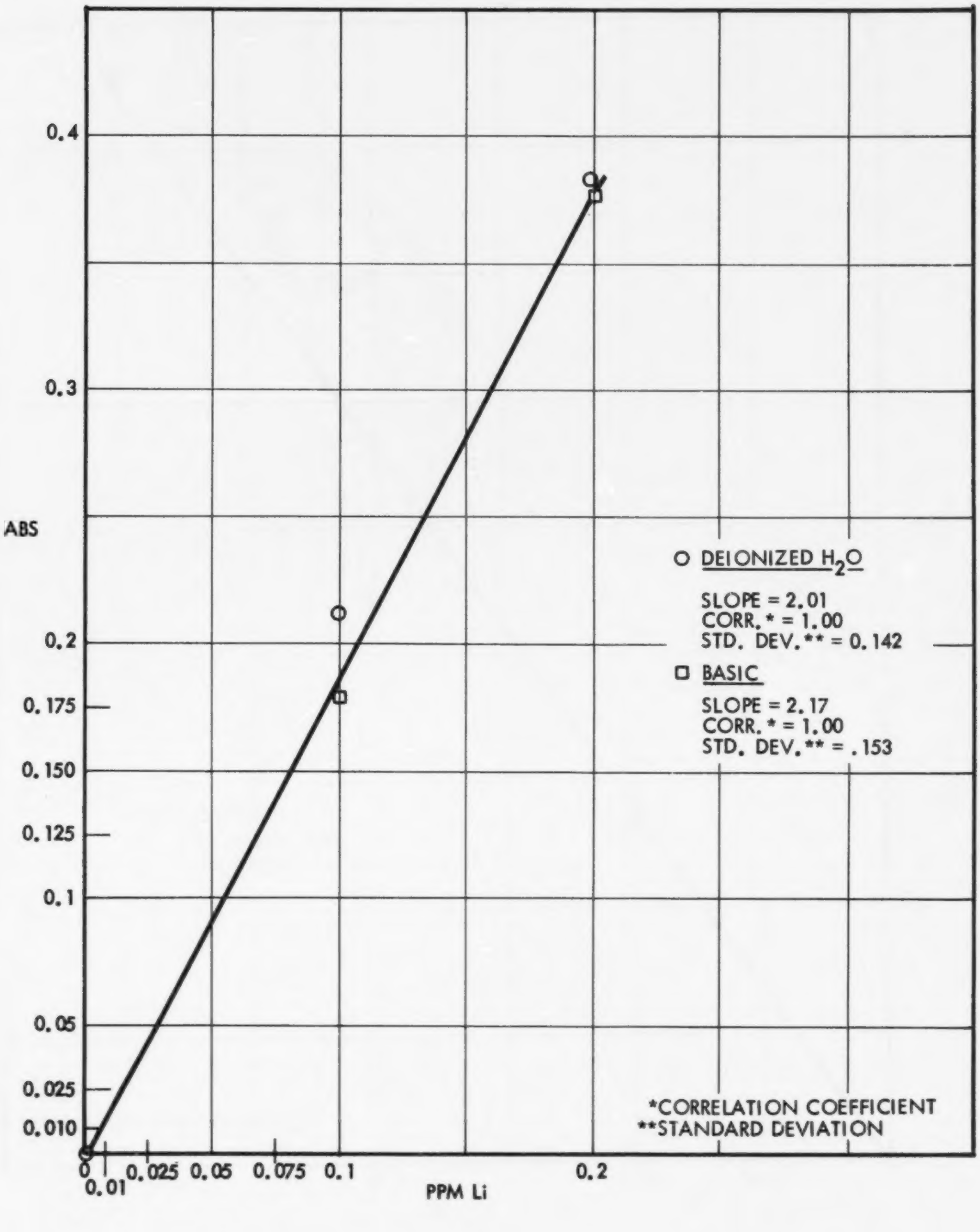
MEG Category	Compound	MATE air $\mu g/m^3$	FBC Emission Samples* $\mu g/m^3$	Comments
1. Aliphatic Hydrocarbons	Alkanes (C>9)	N	$8.0X10^2$	No MATE available for assessment
8D. Esters	Phthalates	$5.0X10^3$	$3.1X10^4$	Exceeds MATE
21. Fused Aromatic Hydrocarbons	Benza (a) anthracene	4.45X10	2.8X10	Does not exceed MATE
	Phenanthrene	$1.59X10^3$	$1.7X10^2$	Does not exceed MATE
	Naphthalene	$5.0X10^4$	$1.5X10^2$	Does not exceed MATE
	Anthracene, Methyl Anthracene	$5.6X10^4$	$1.2X10^2$	Does not exceed MATE
	Pyrene	$2.33X10^5$	3.5X10	Does not exceed MATE
22. Fused Non-Alternate Polycyclic Hydrocarbons	Benzofluoranthrene	$6.48X10^3$	1.0X10	Does not exceed MATE
	Fluoranthrene	$9.0X10^4$	$1.3X10^2$	Does not exceed MATE

* Summation of S-2-5, S-2-6 and S-2-7

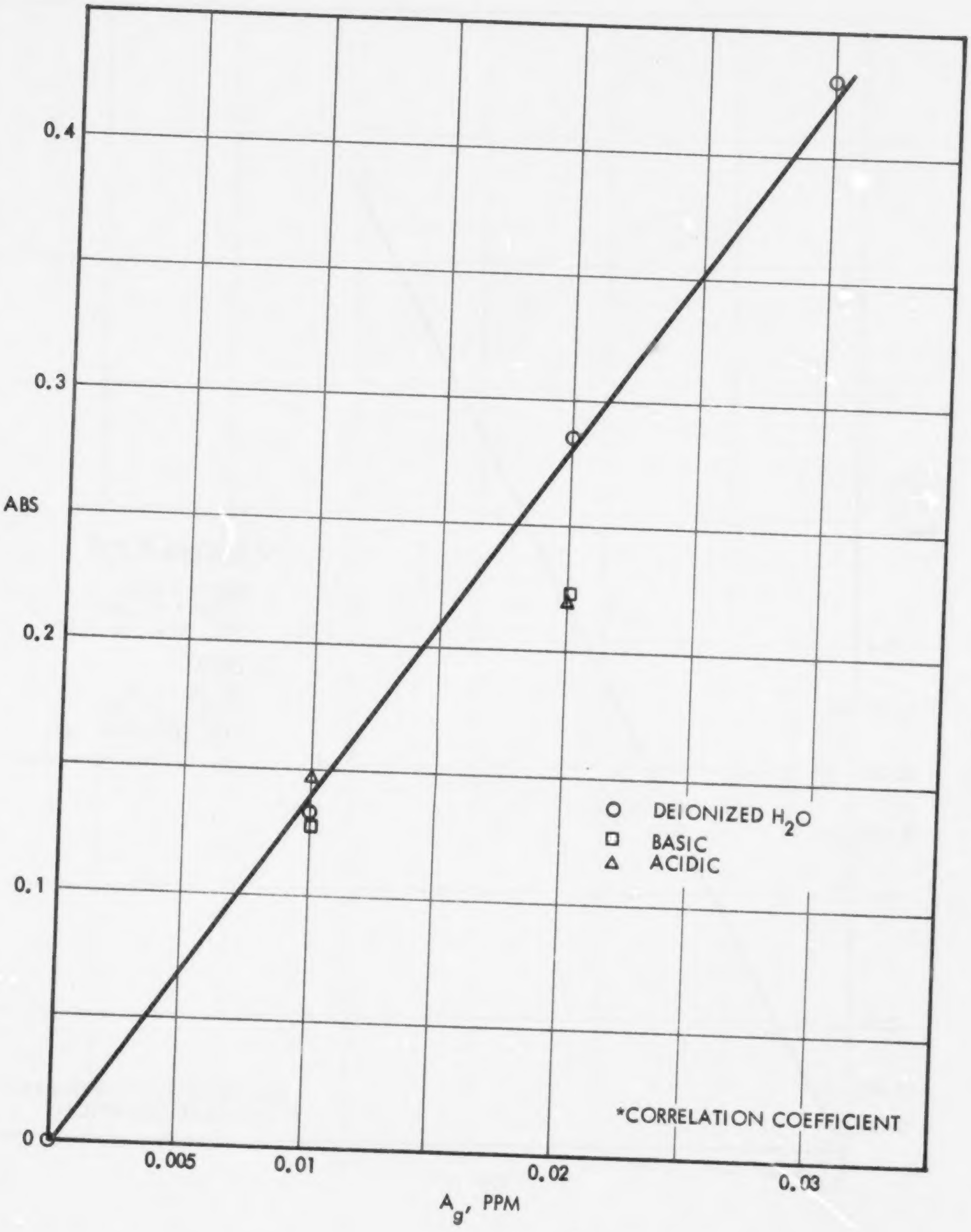
APPENDIX A

ATOMIC ABSORPTION CALIBRATION CURVES

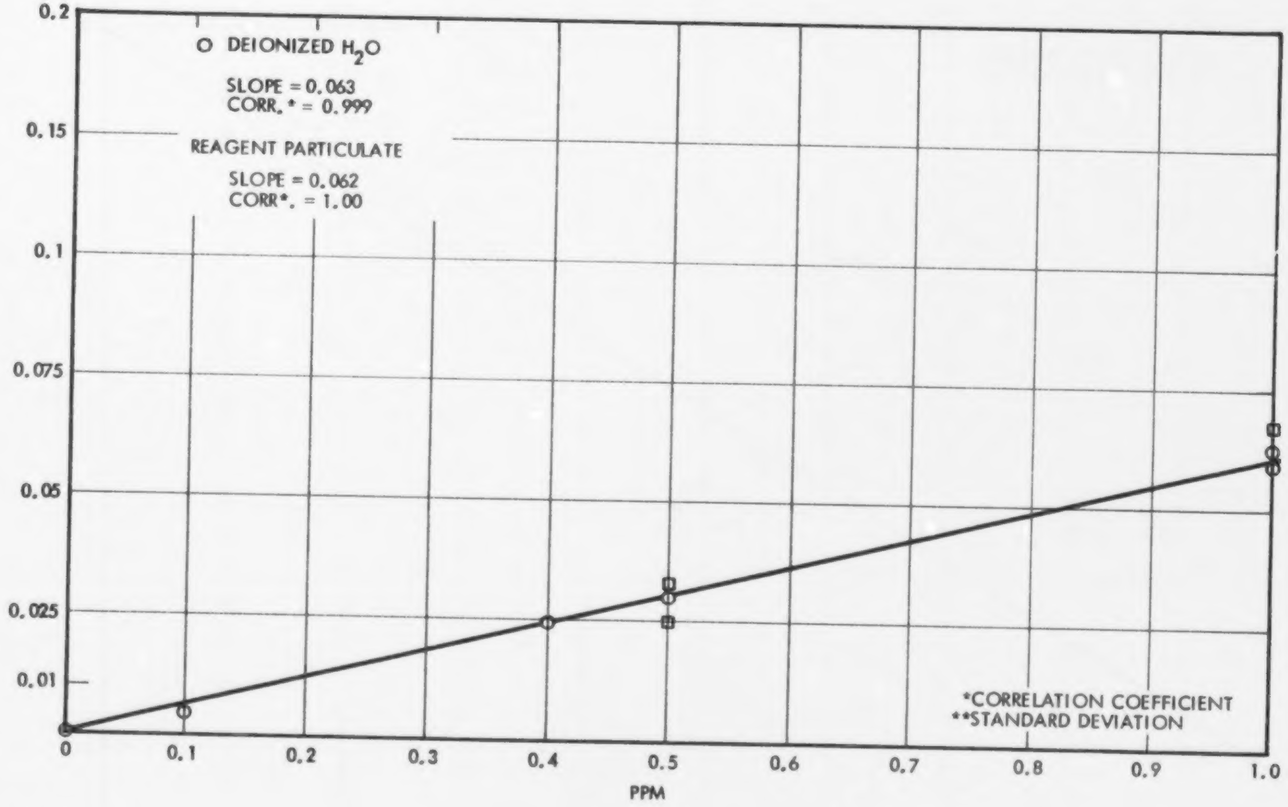
A-1. Lithium Calibration Curve for Atomic Emission Procedure



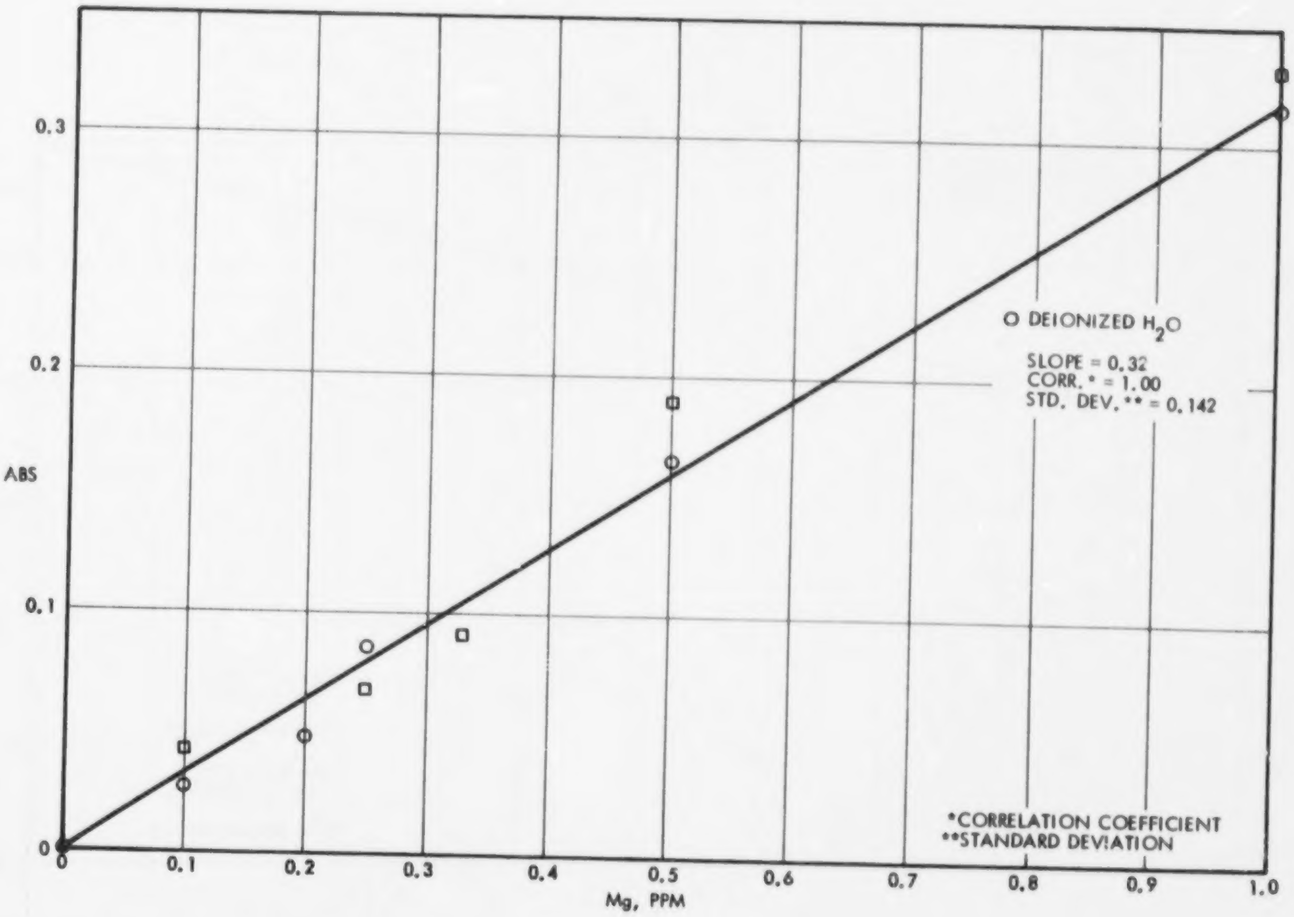
A-2. Silver Calibration Curve for Atomic Absorption Procedure



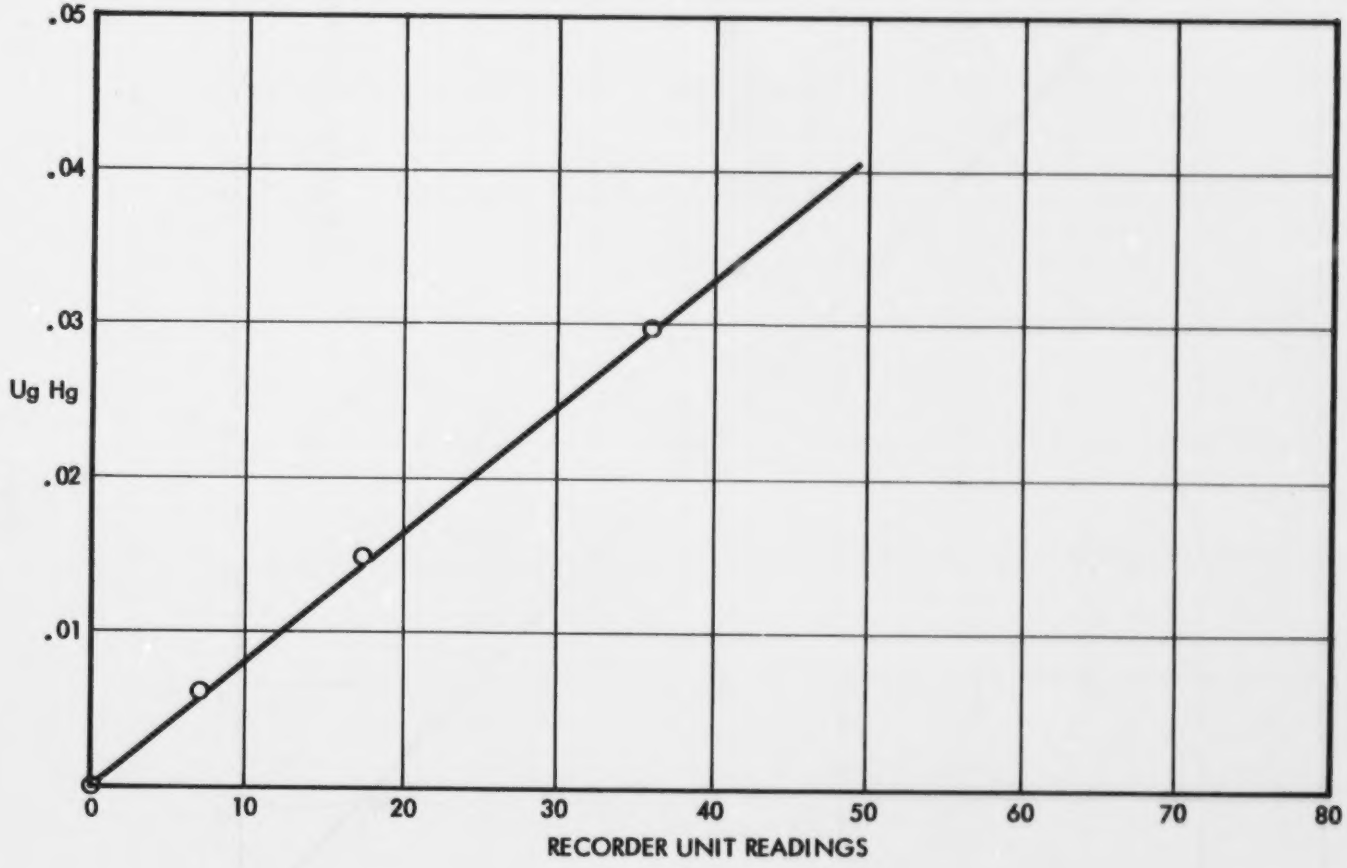
A-3. Chromium Calibration Curve for Atomic Absorption Procedure



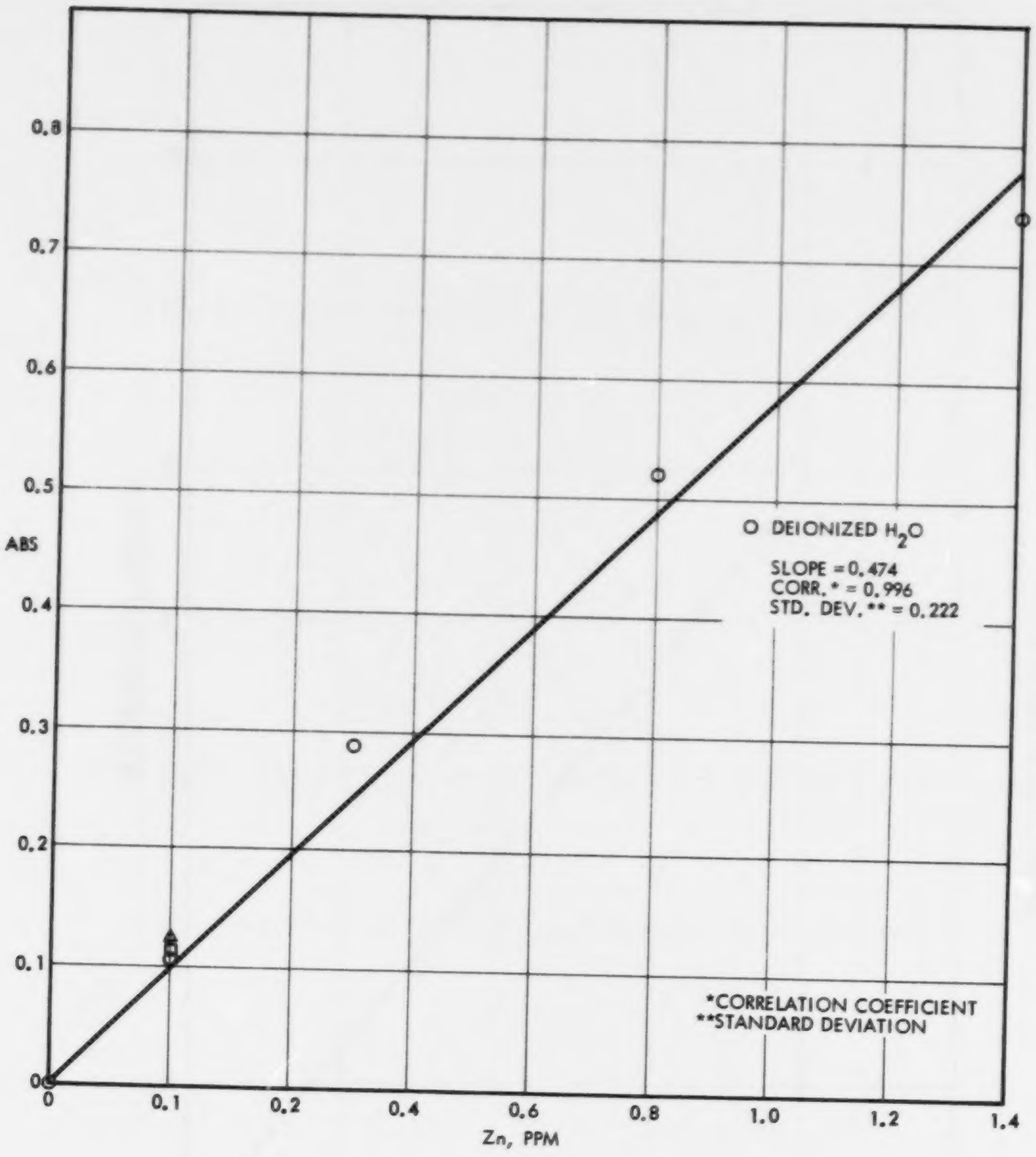
A-4. Magnesium Calibration Curve
for Atomic Absorption Procedure



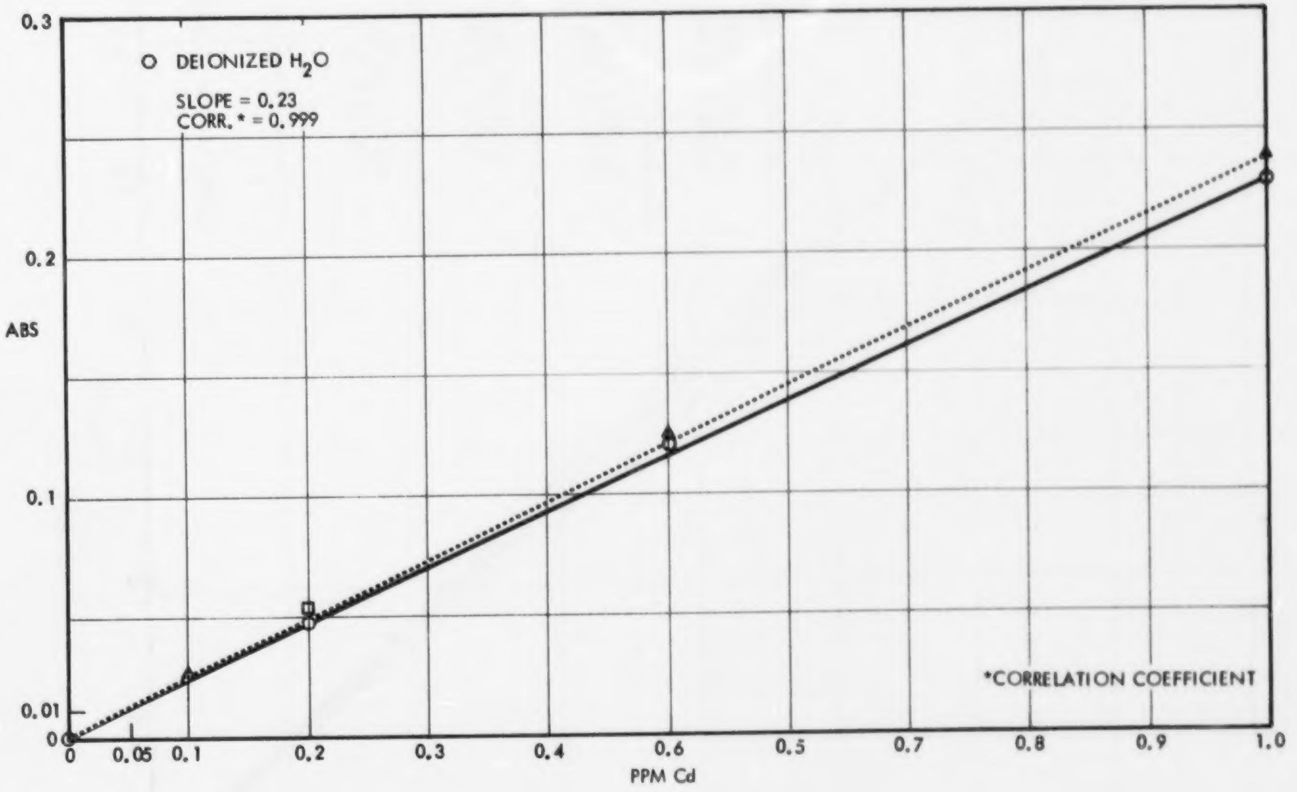
A-5. Mercury Calibration Curve for the Cold Vapor Trap Procedure



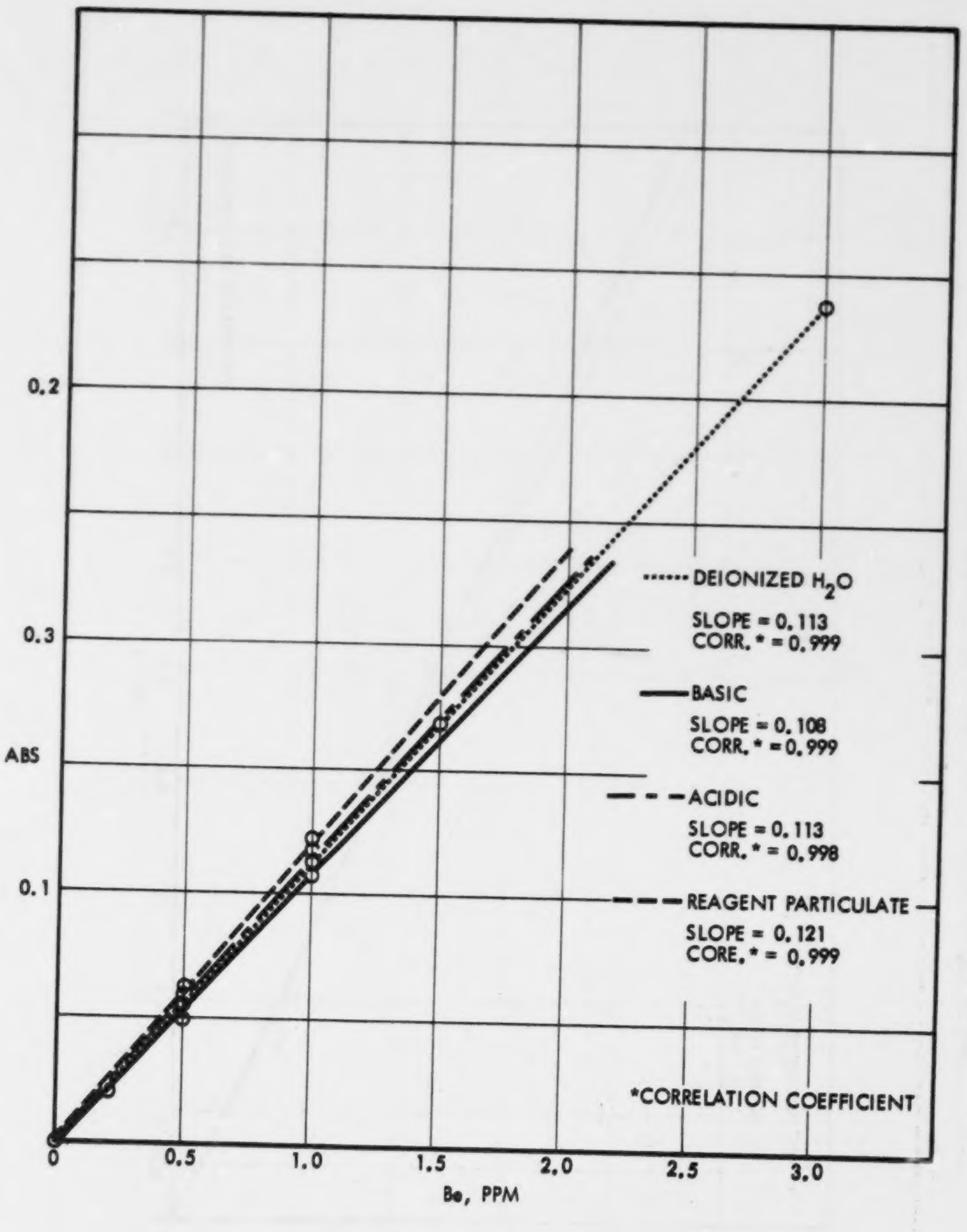
A-6. Zinc Calibration Curve for Atomic Absorption Procedure



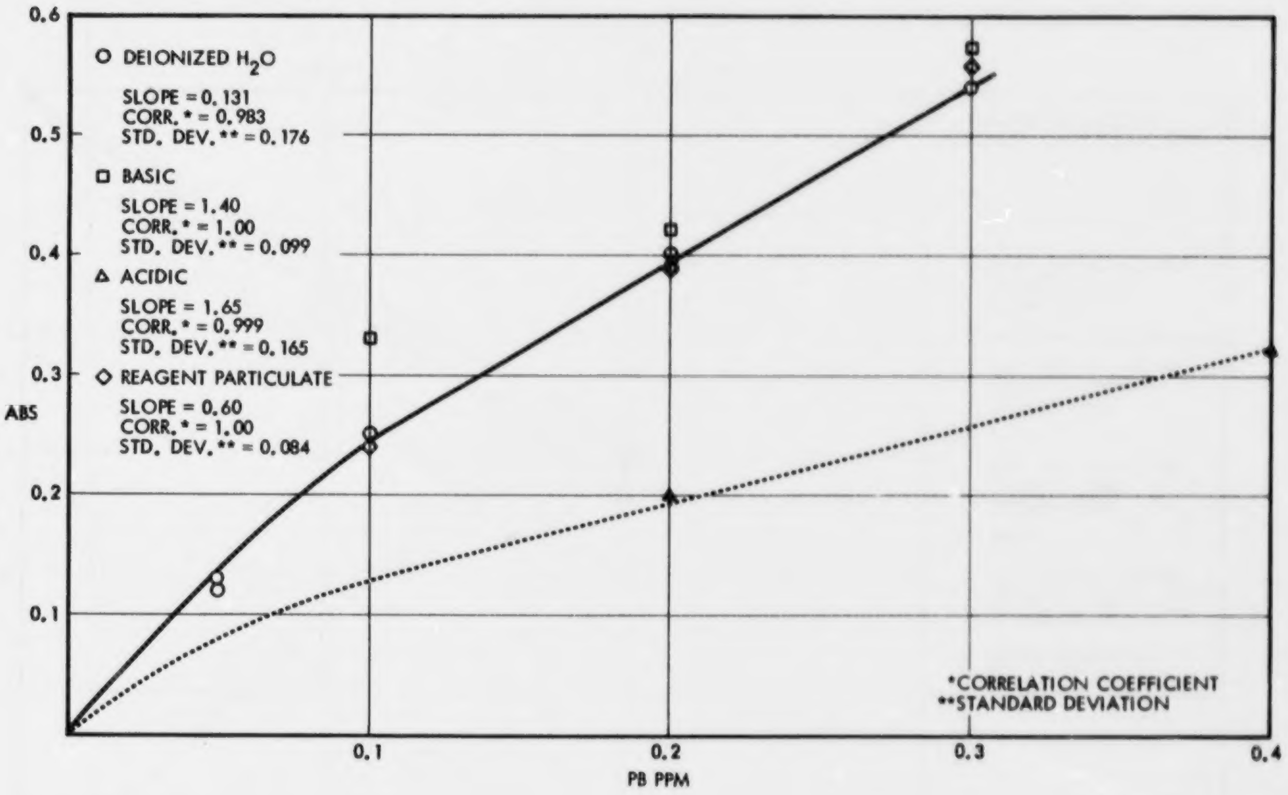
A-7. Cadmium Calibration Curve For Atomic Absorption Procedure



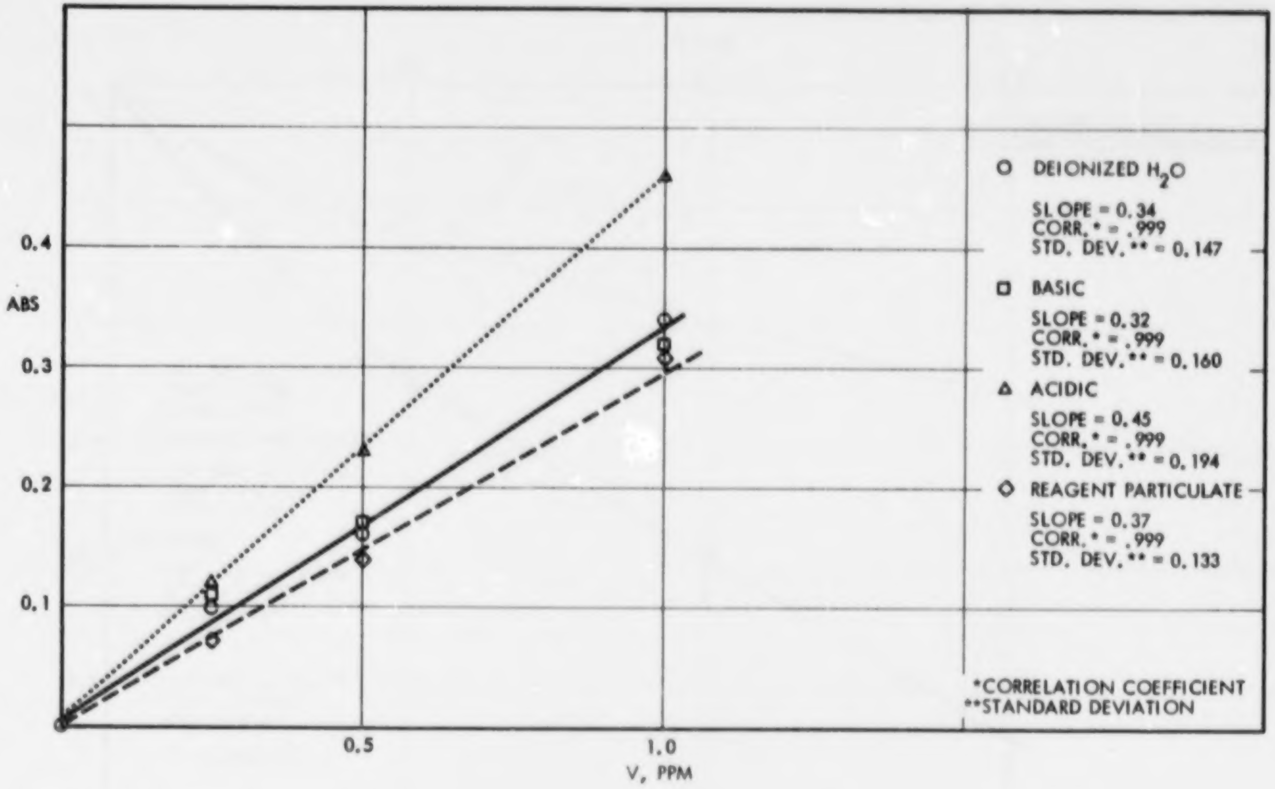
A-8 Beryllium Calibration Curve for Atomic Absorption Procedure



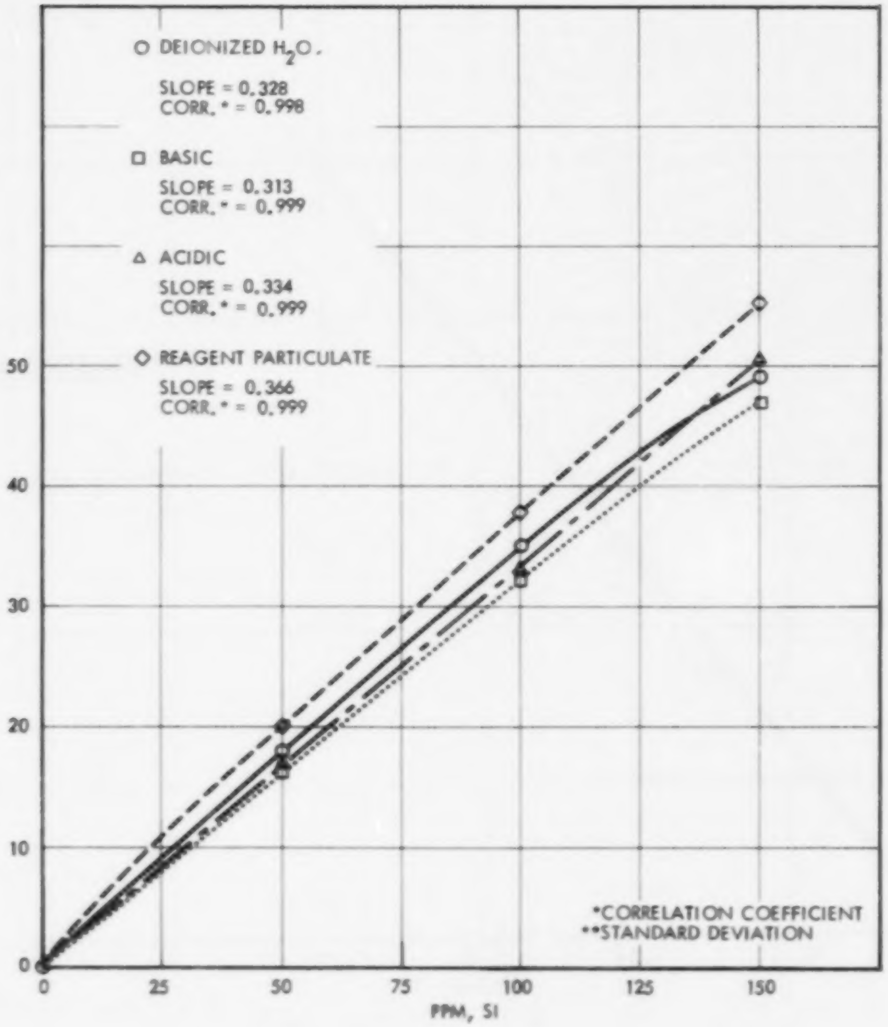
A-9. Lead Calibration Curve for Atomic Absorption Procedure.



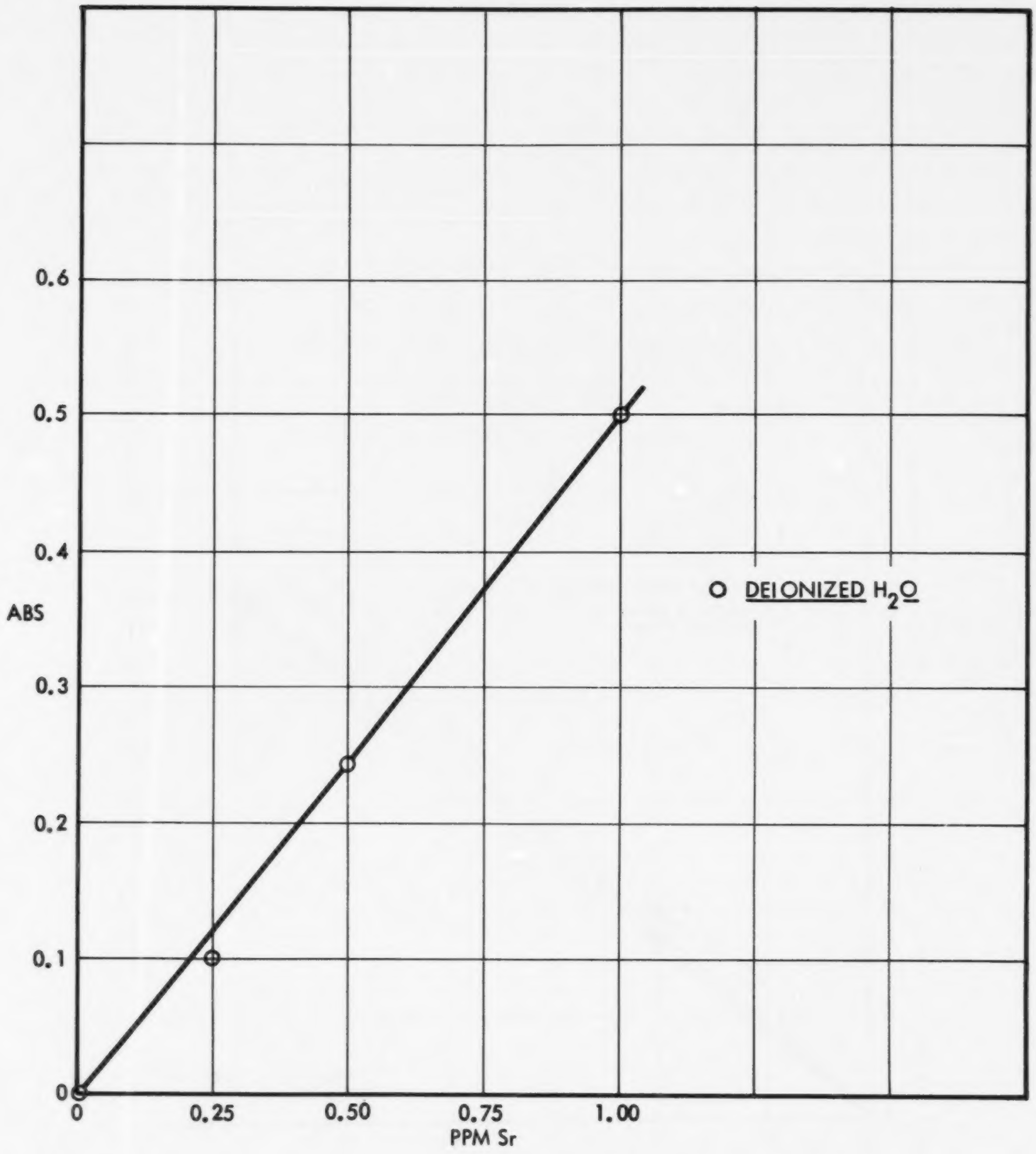
A-10. Vanadium Calibration Curve for Atomic Absorption Procedure



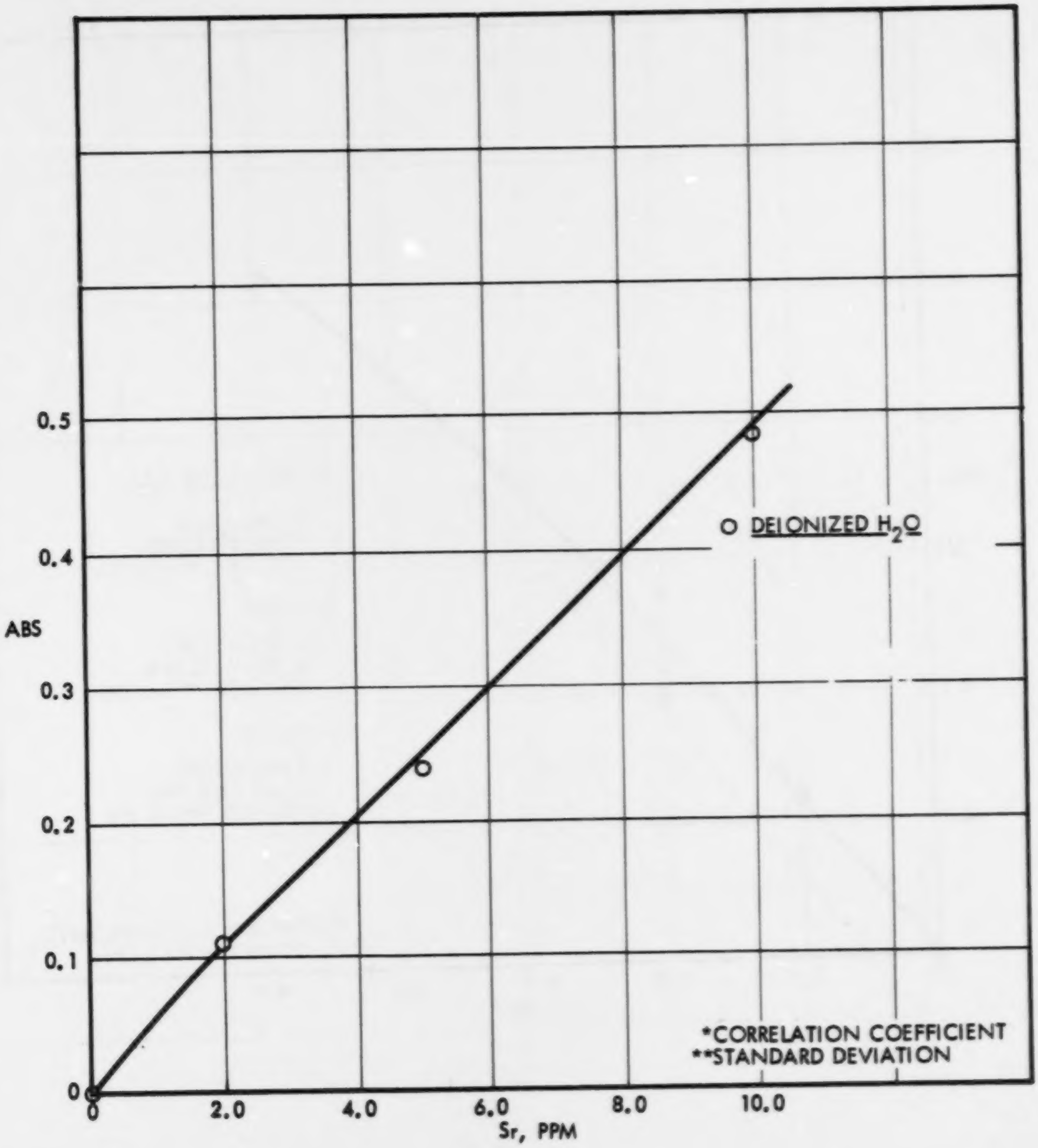
A-11. Silicon Calibration Curve for Atomic Absorption Procedure



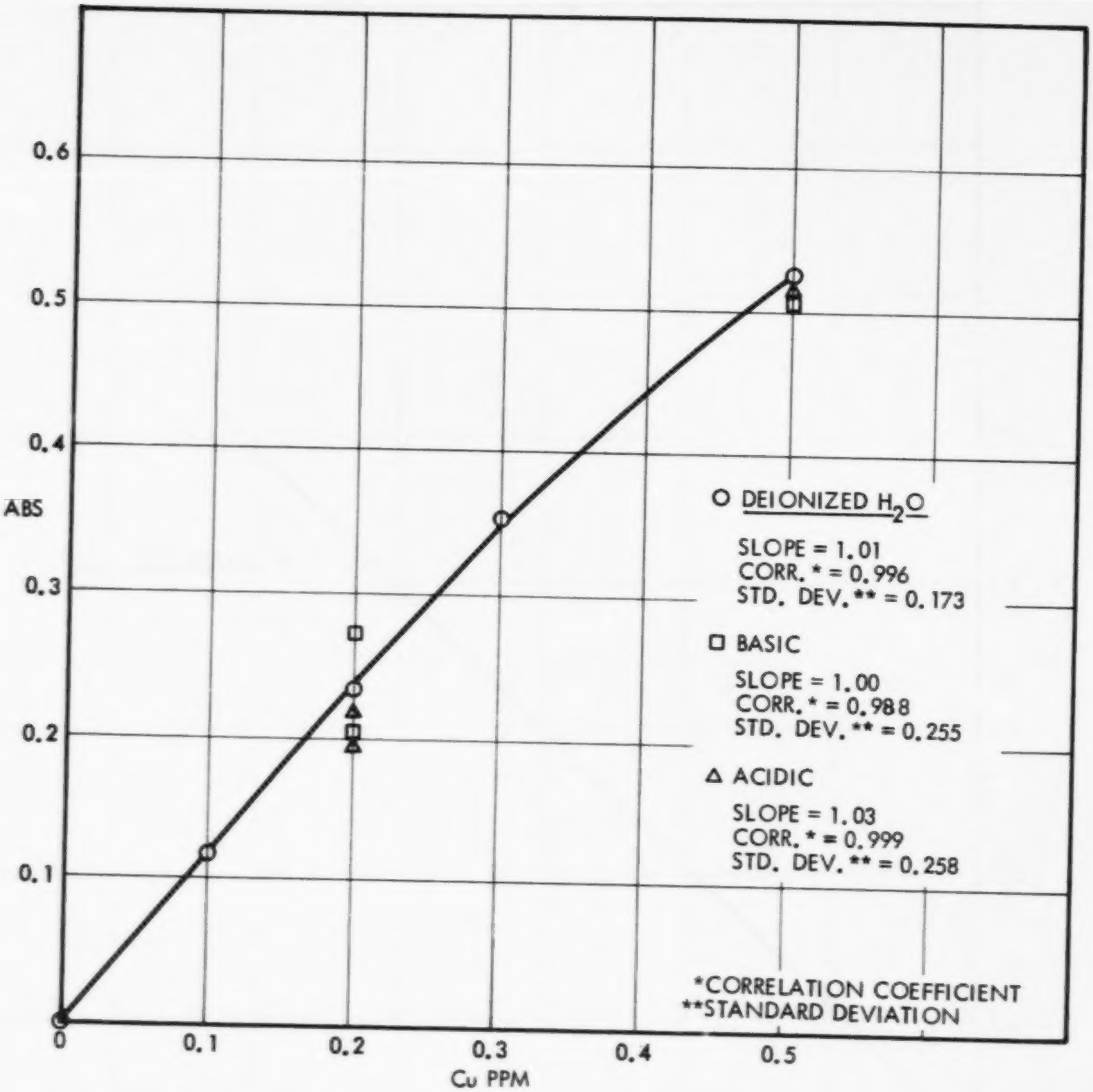
A-12. Strontium Calibration Curve for Atomic Absorption Procedure, Range 0.0-1.00 ppm



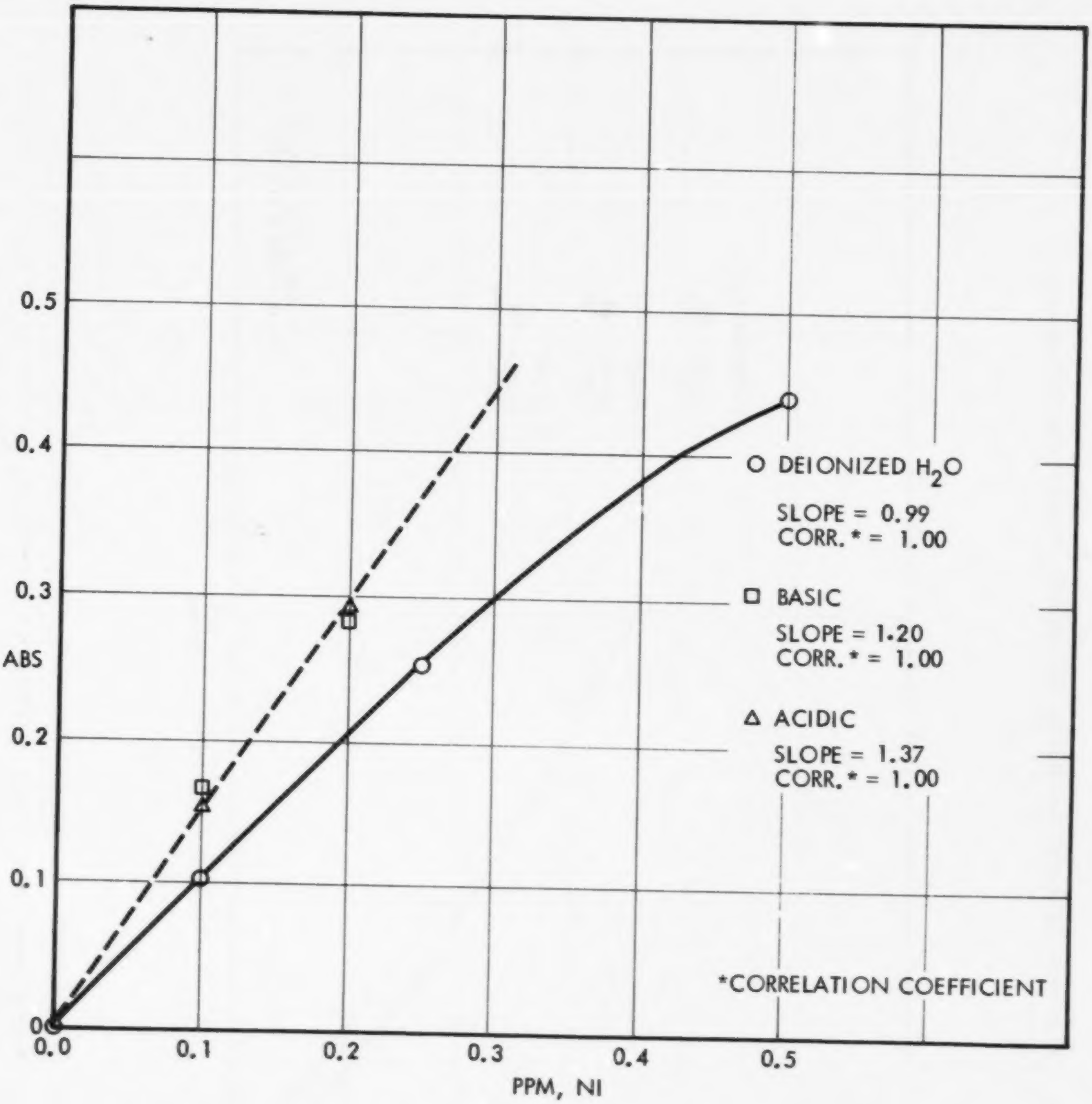
A-13. Strontium Calibration Curve for Atomic Absorption Procedure, Range 0.0-10.0 ppm



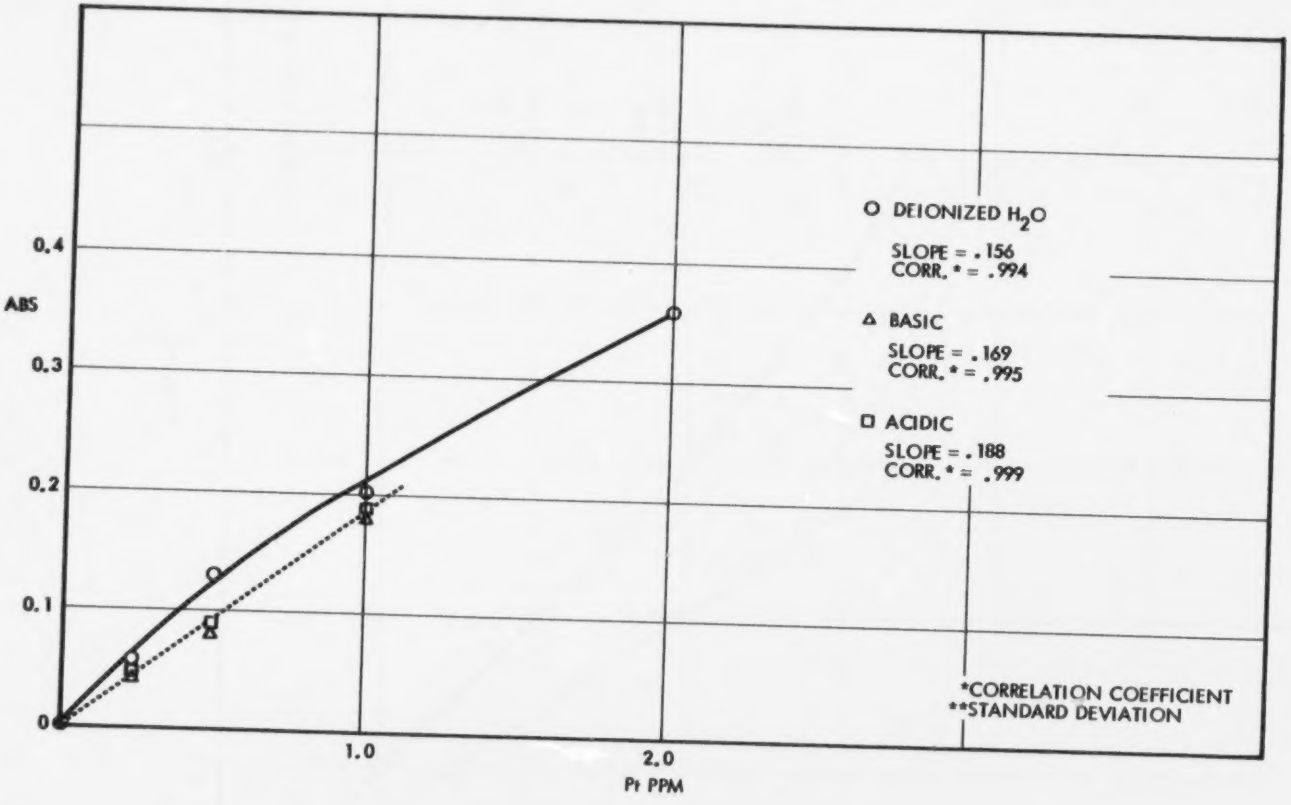
A-14. Copper Calibration Curve for Atomic Absorption Procedure



A-15. Nickel Calibration Curve for Atomic Absorption Procedure

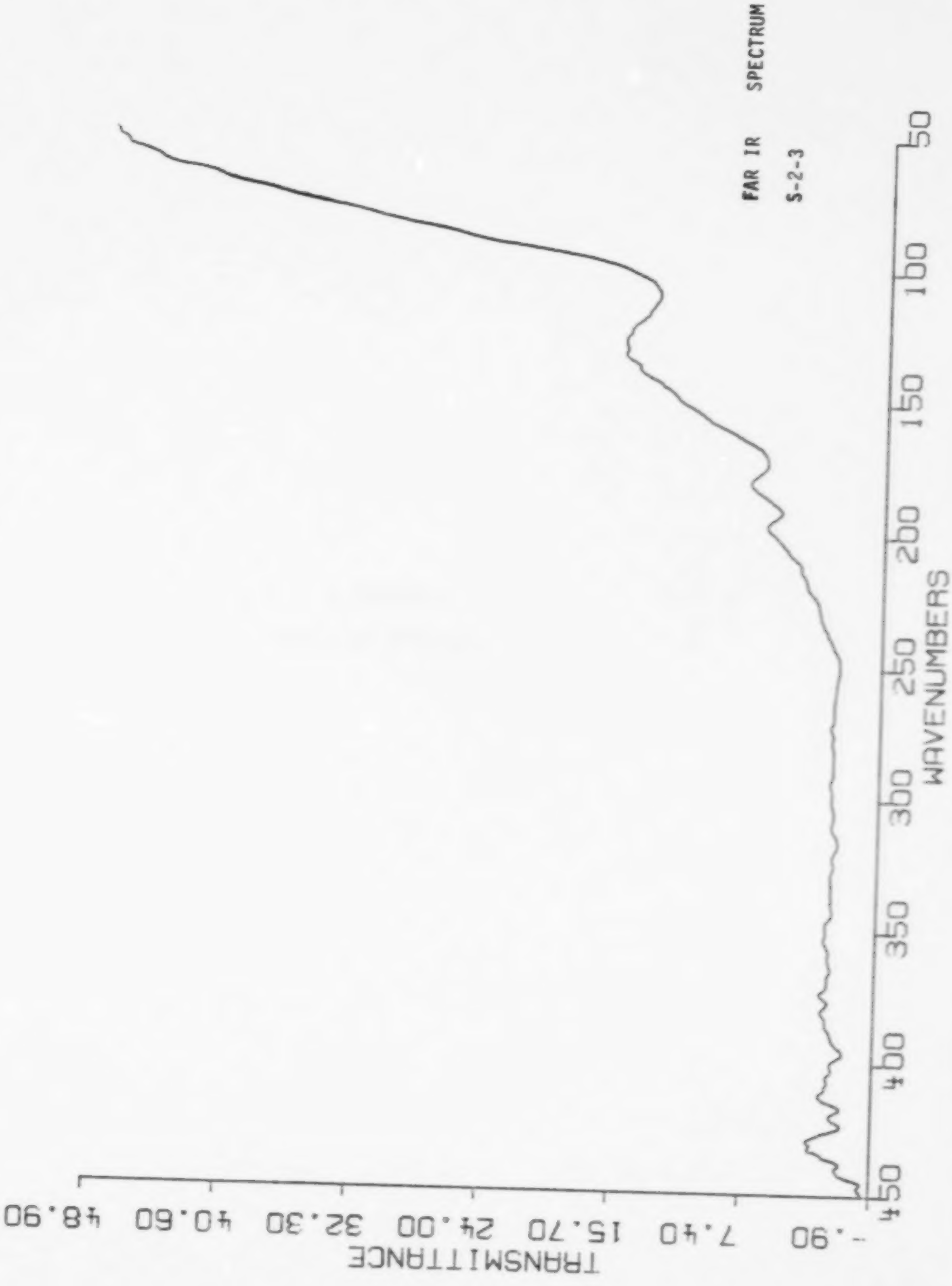


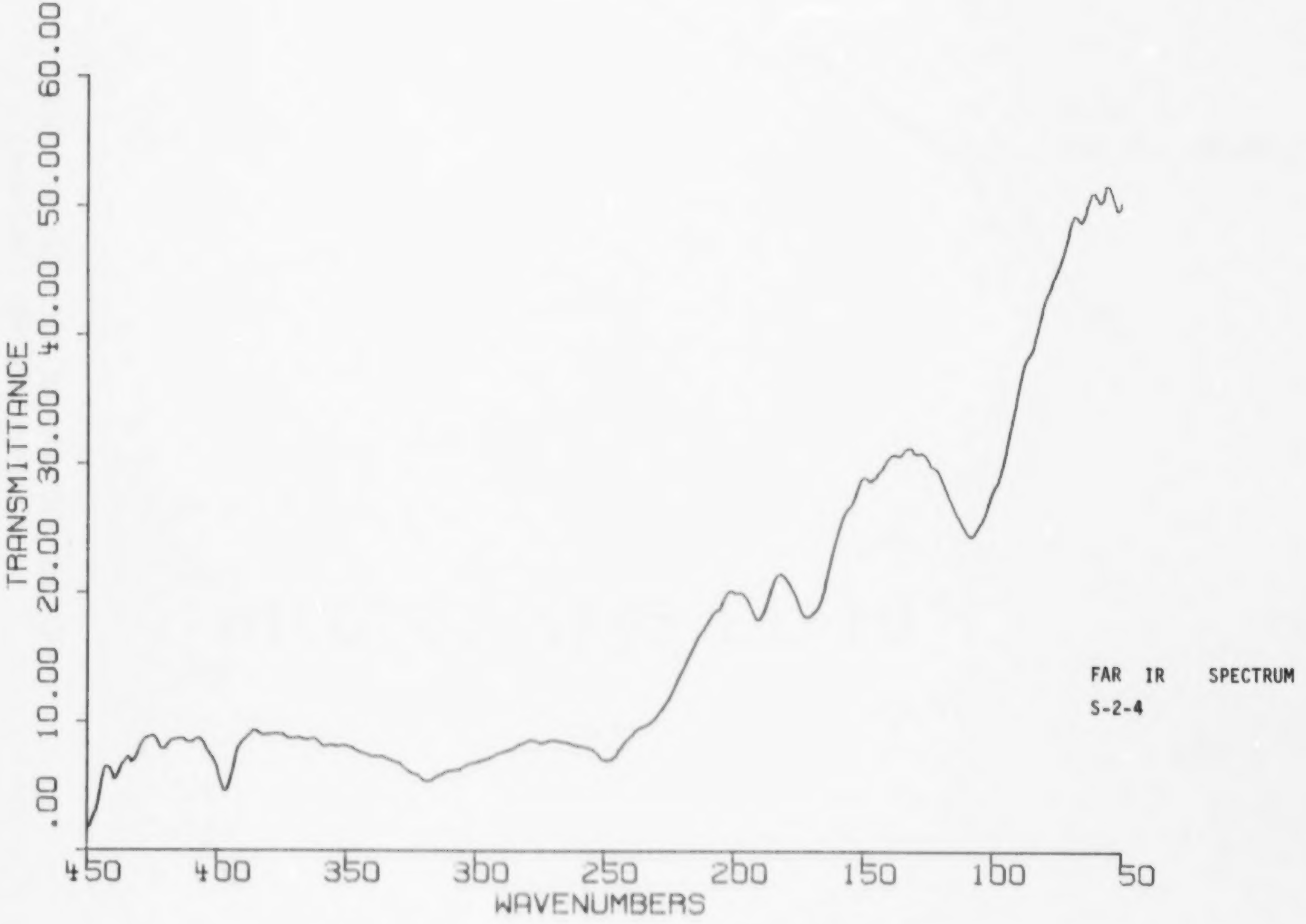
A-16. Platinum Calibration Curve for Atomic Absorption Procedure

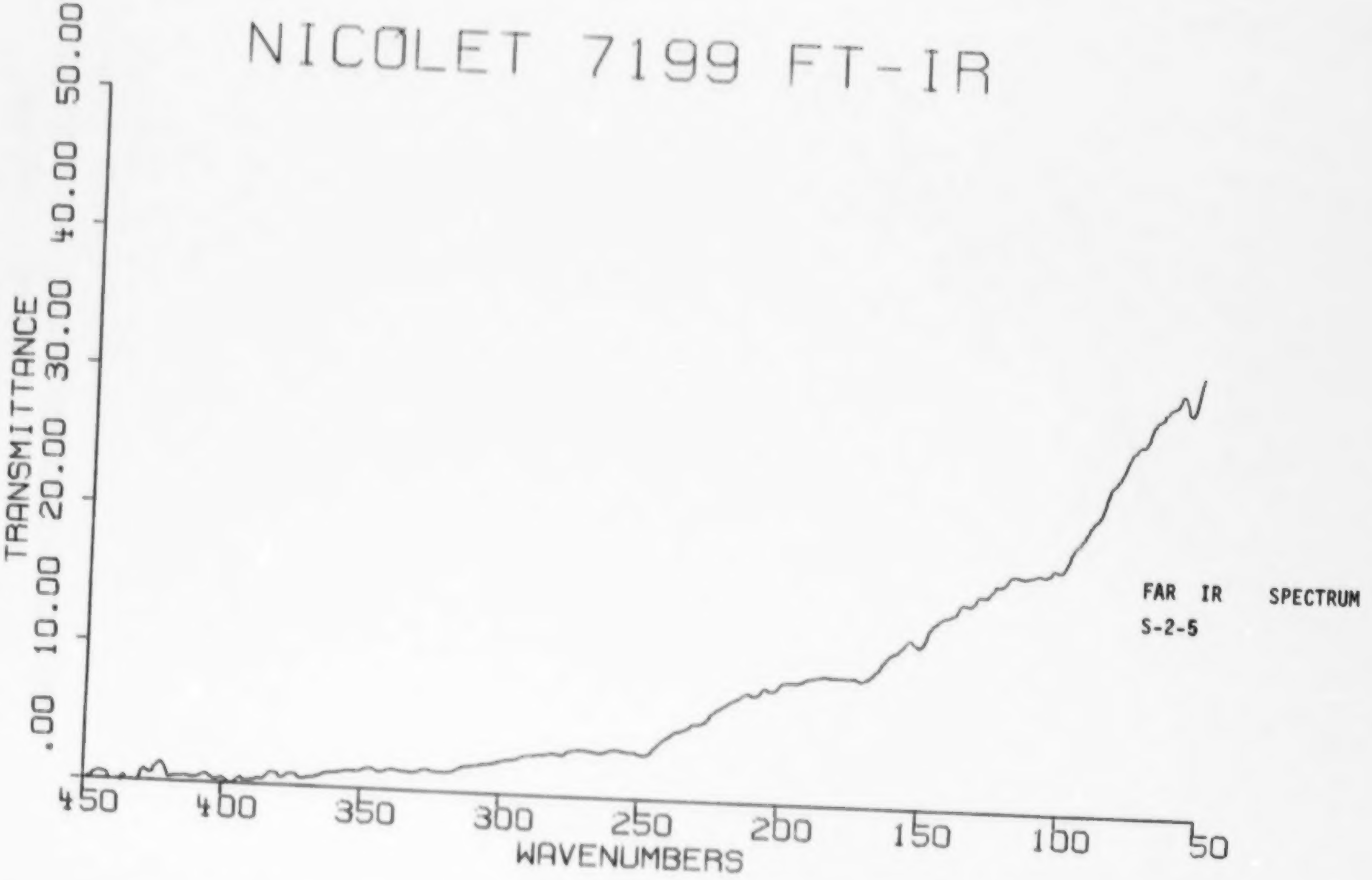


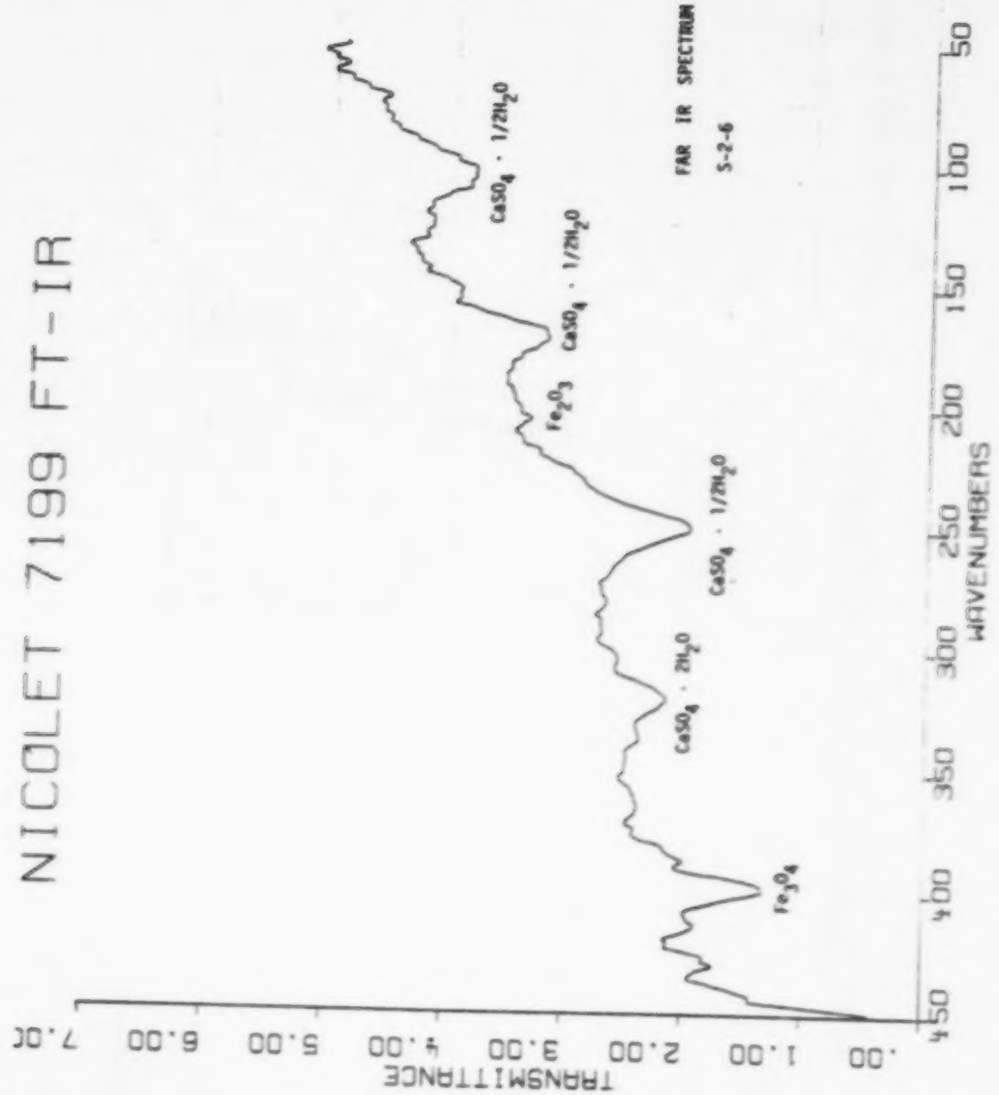
APPENDIX B

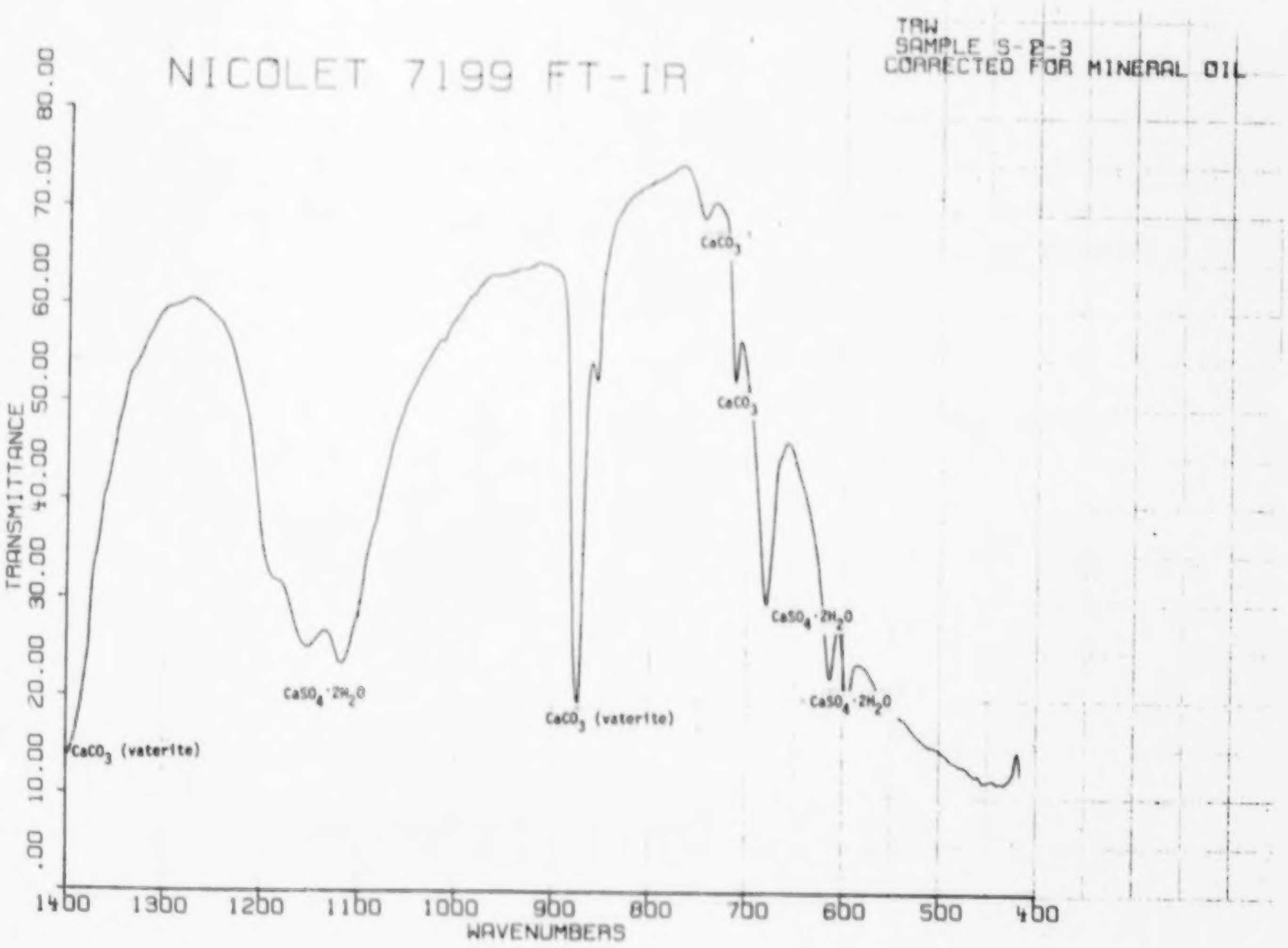
FTIR SPECTRAL SCANS

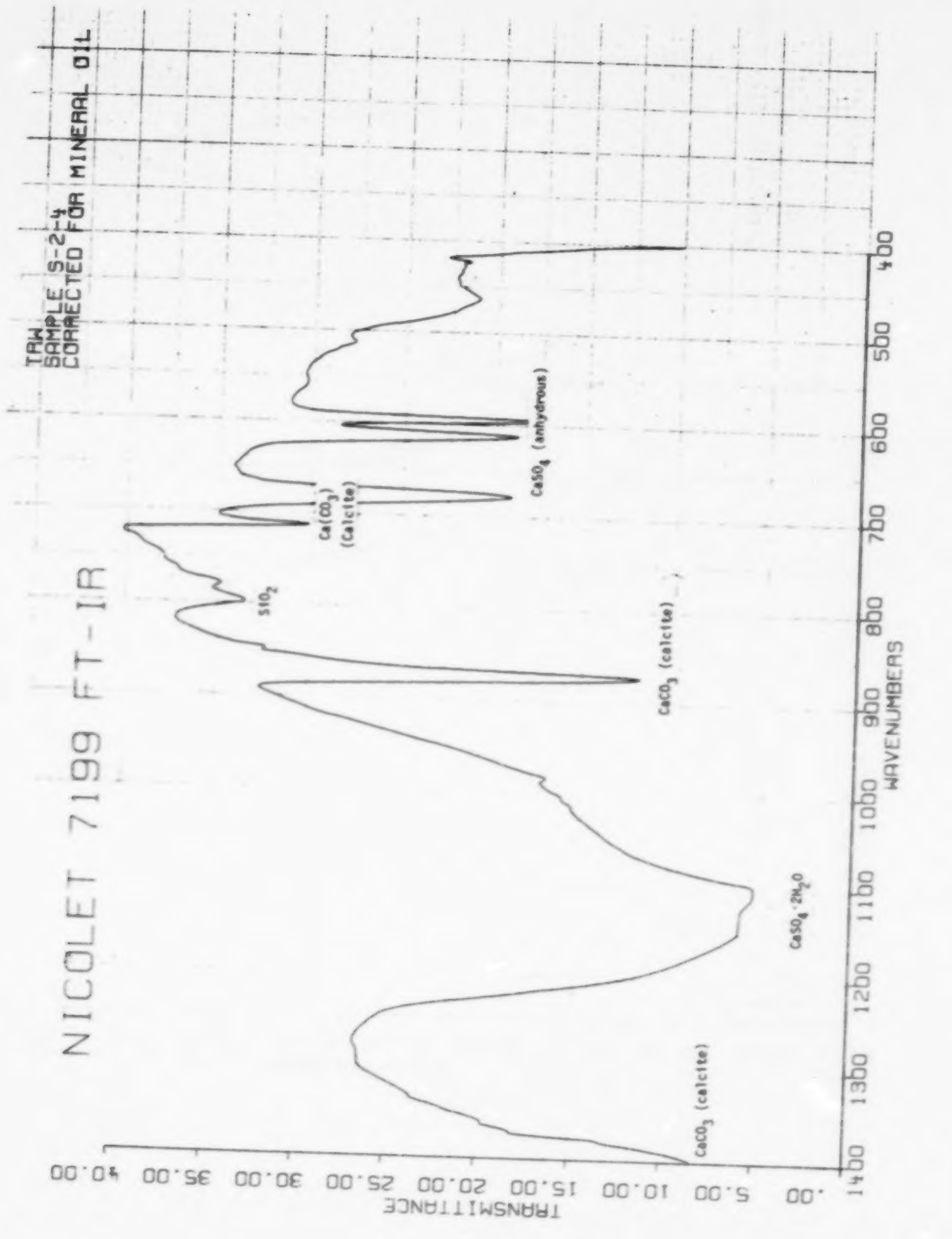

FAR IR SPECTRUM
S-2-3
WAVENUMBERS
50
100
150
200
250
300
350
400
450
TRANSMITTANCE
-.90
7.40
15.70
24.00
32.30
40.60
48.90

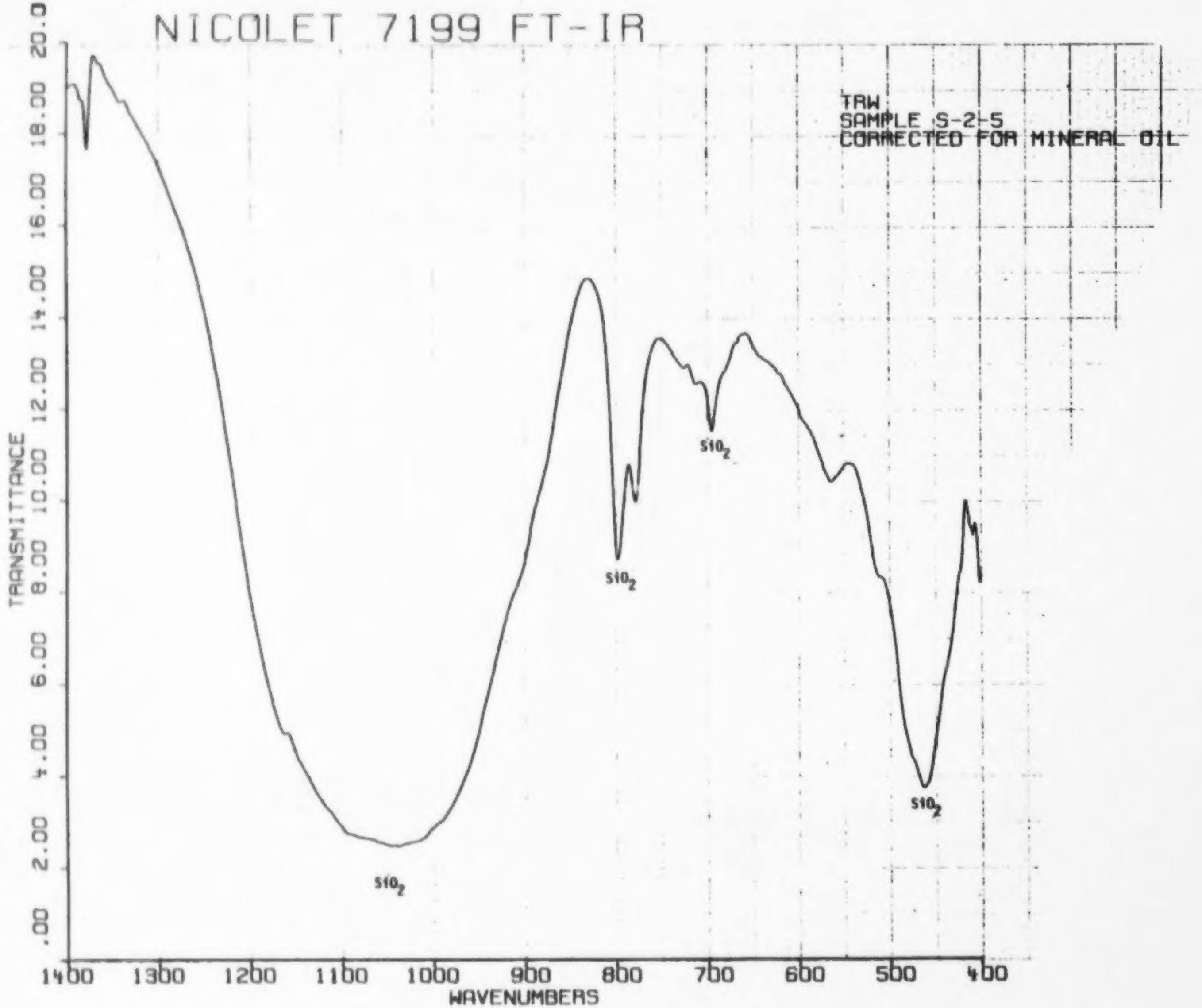

TRANSMITTANCE
.00
10.00
20.00
30.00
40.00
50.00
60.00
450
400
350
300
250
200
150
100
50
WAVENUMBERS
FAR IR SPECTRUM
S-2-4

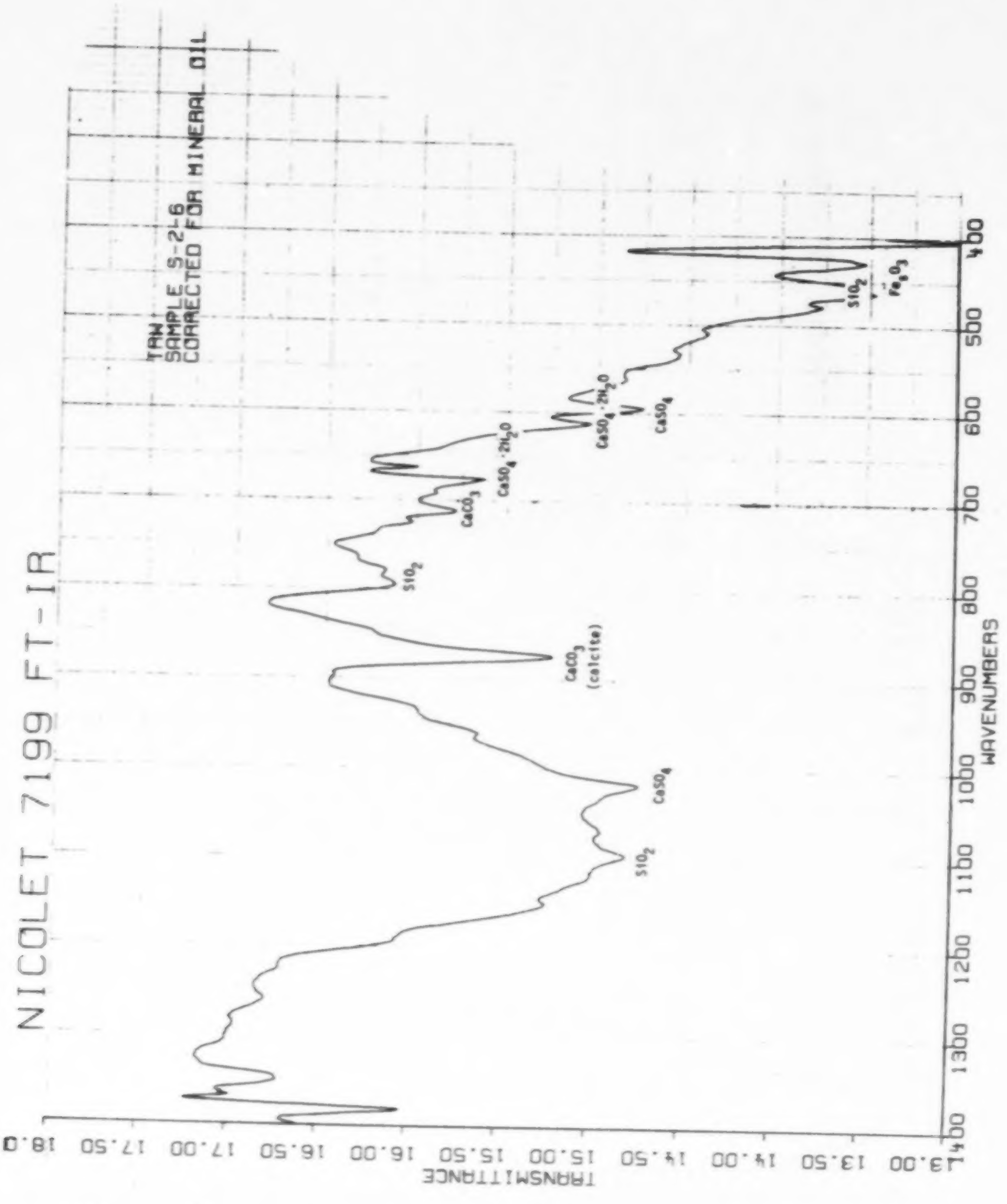

NICOLET 7199 FT-IR
TRANSMITTANCE
.00
10.00
20.00
30.00
40.00
50.00
WAVENUMBERS
450
400
350
300
250
200
150
100
50
FAR IR SPECTRUM
S-2-5

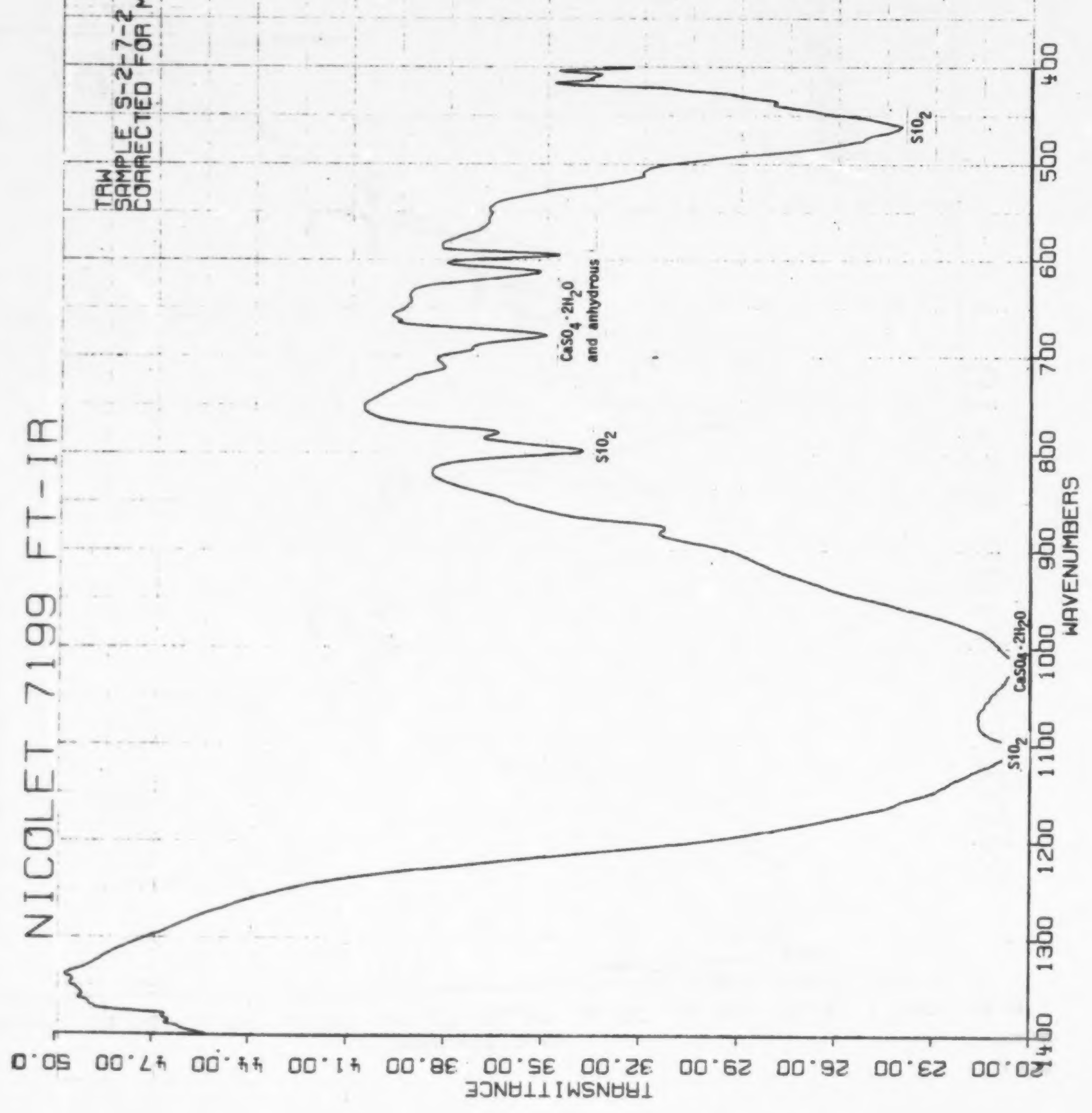

NICOLET 7199 FT-IR
FAR IR SPECTRUM
S-2-6
$CaSO_4 \cdot 1/2H_2O$
$CaSO_4 \cdot 1/2H_2O$
Fe_2O_3
$CaSO_4 \cdot 1/2H_2O$
$CaSO_4 \cdot 2H_2O$
Fe_3O_4
TRANSMITTANCE
.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
WAVENUMBERS
450
400
350
300
250
200
150
100
50

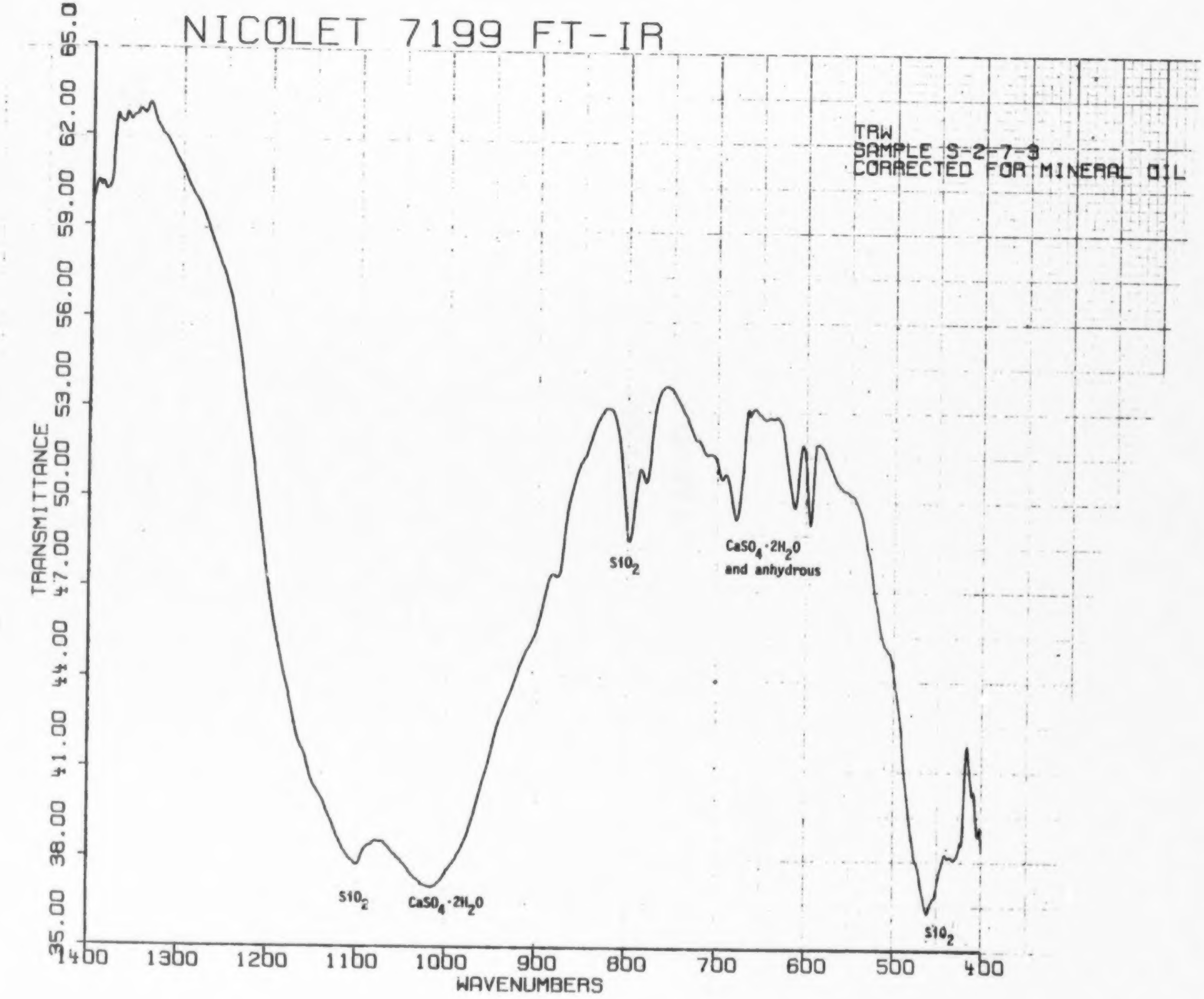

NICOLET 7199 FT-IR
TRW
SAMPLE S-2-3
CORRECTED FOR MINERAL OIL
TRANSMITTANCE
.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
WAVENUMBERS
1400
1300
1200
1100
1000
900
800
700
600
500
400
$CaCO_3$ (vaterite)
$CaSO_4 \cdot 2H_2O$
$CaCO_3$ (vaterite)
$CaCO_3$
$CaCO_3$
$CaSO_4 \cdot 2H_2O$
$CaSO_4 \cdot 2H_2O$


NICOLET 7199 FT-IR
TAW
SAMPLE S-2-4
CORRECTED FOR MINERAL OIL
TRANSMITTANCE
.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
WAVENUMBERS
1400
1300
1200
1100
1000
900
800
700
600
500
400
$CaCO_3$ (calcite)
$CaSO_4 \cdot 2H_2O$
$CaCO_3$ (calcite)
SiO_2
$Ca(CO_3)$ (Calcite)
$CaSO_4$ (anhydrous)


NICOLET 7199 FT-IR
TRW
SAMPLE S-2-5
CORRECTED FOR MINERAL OIL
TRANSMITTANCE
20.0
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
.00
1400
1300
1200
1100
1000
900
800
700
600
500
400
WAVENUMBERS
SiO2
SiO2
SiO2
SiO2

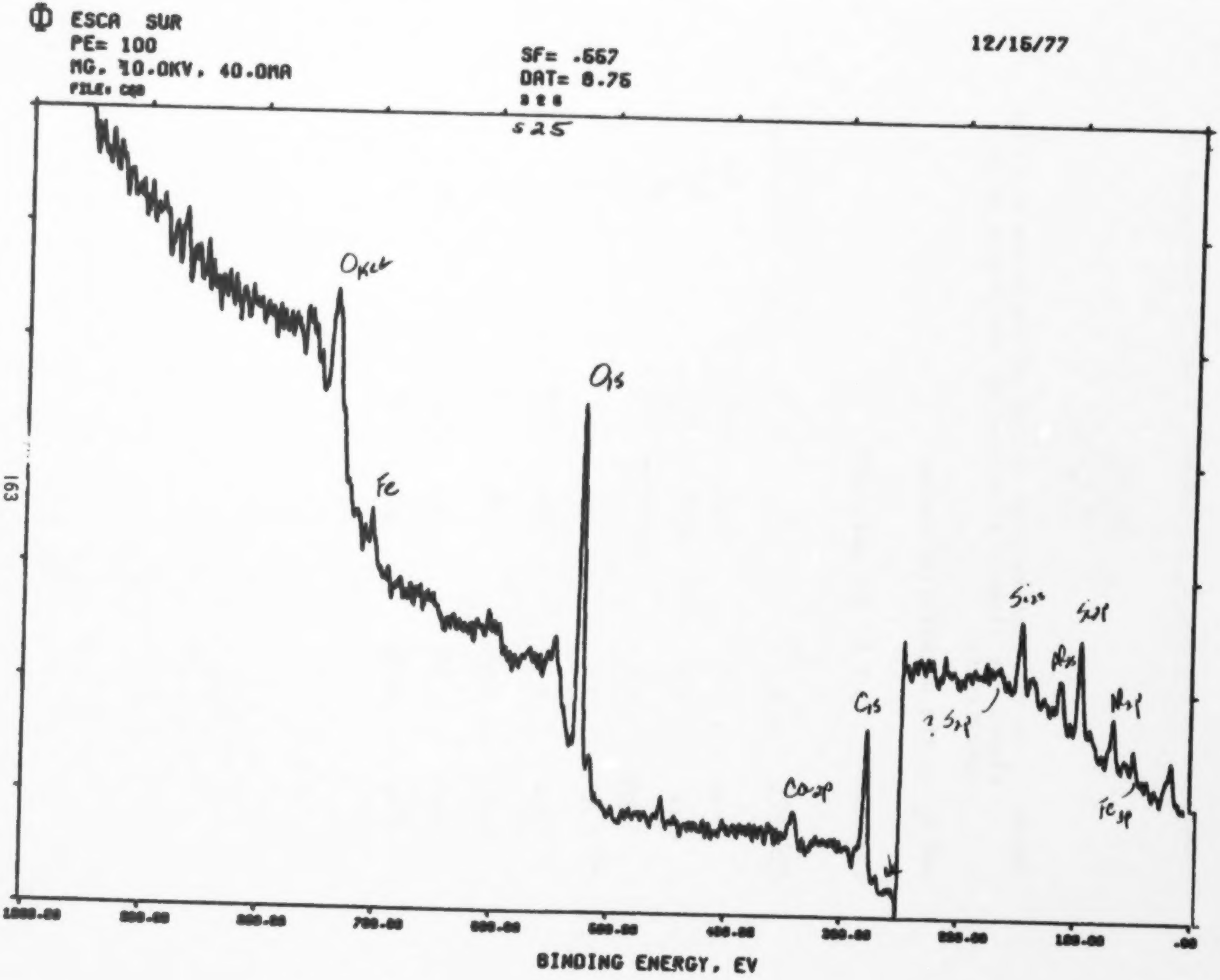

NICOLET 7199 FT-IR
TAW
SAMPLE S-2-6
CORRECTED FOR MINERAL OIL
TRANSMITTANCE
13.00
13.50
14.00
14.50
15.00
15.50
16.00
16.50
17.00
17.50
18.0
WAVENUMBERS
1400
1300
1200
1100
1000
900
800
700
600
500
400
SiO2
CaSO4
CaCO3 (calcite)
SiO2
CaCO3
CaSO4·2H2O
CaSO4·2H2O
CaSO4
SiO2
Fe2O3


NICOLET 7199 FT-IR
TRW
SAMPLE S-2-7-2
CORRECTED FOR MINERAL OIL
TRANSMITTANCE
20.00
23.00
26.00
29.00
32.00
35.00
38.00
41.00
44.00
47.00
50.0
WAVENUMBERS
1400
1300
1200
1100
1000
900
800
700
600
500
400
SiO2
CaSO4·2H2O
SiO2
CaSO4·2H2O and anhydrous
SiO2


NICOLET 7199 FT-IR
TRW
SAMPLE S-2-7-3
CORRECTED FOR MINERAL OIL
TRANSMITTANCE
65.0
62.00
59.00
56.00
53.00
50.00
47.00
44.00
41.00
38.00
35.00
WAVENUMBERS
1400
1300
1200
1100
1000
900
800
700
600
500
400
SiO_2
$CaSO_4 \cdot 2H_2O$
SiO_2
$CaSO_4 \cdot 2H_2O$ and anhydrous
SiO_2

APPENDIX C

ESCA SCANS


Φ ESCA SUR
PE= 100
MG. 10.0KV, 40.0MA
FILE: C80
SF= .567
DAT= 8.76
328
525
12/15/77
OKLL
Fe
O1s
Co2p
C1s
? S2p
Si2s
Si2p
Al2s
Al2p
Fe3p
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
.00
BINDING ENERGY, EV

Atomic concentration C_x of element X may be estimated by

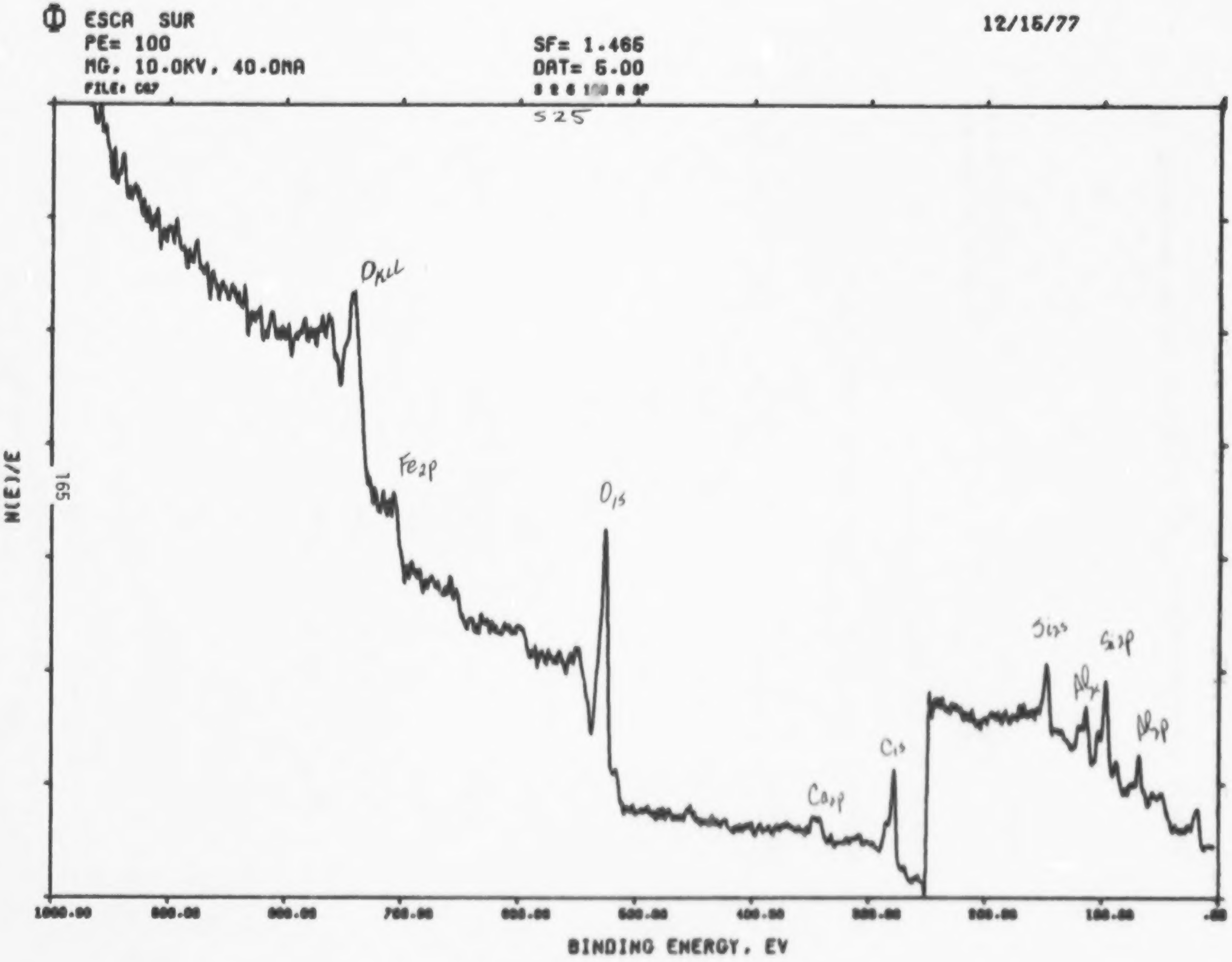
$$C_x = \frac{I_x/S_x}{\Sigma_\alpha I_\alpha/S_\alpha}$$

Where, I_x is the peak-to-peak height of the Auger electron signal for element X divided by the proper scale sensitivity

and S_x is the sensitivity factor

EXAMPLE: S 25 AS RECEIVED

ELEMENT	I_x (Cm)	S_x	I_x/S_x	C_x	Atom Percent
Fe_{2p}	1.0	1.55	0.6		3
O_{1s}	7.6	0.63	12.1		64
CA_{2p}	0.6	.71	0.8		4
* C_{1s}	3.0	.205	-		
Na_{1s}	0.1	2.54	0.04		.2
S_{2p}	0.2/4	.28	0.2		1
Si_{2s}	1.7/4	.104	3.4		18
Al_{2s}	0.7/4	.095	1.8		10
			18.9		


ESCA SUR
PE= 100
MG, 10.0KV, 40.0MA
FILE: C67
SF= 1.466
DAT= 5.00
525
12/15/77
N(E)/E
165
OKLL
Fe2p
O1s
Ca2p
C1s
Si2s
Al2s
Si2p
Al2p
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
.00
BINDING ENERGY, EV

Atomic concentration C_x of element X may be estimated by

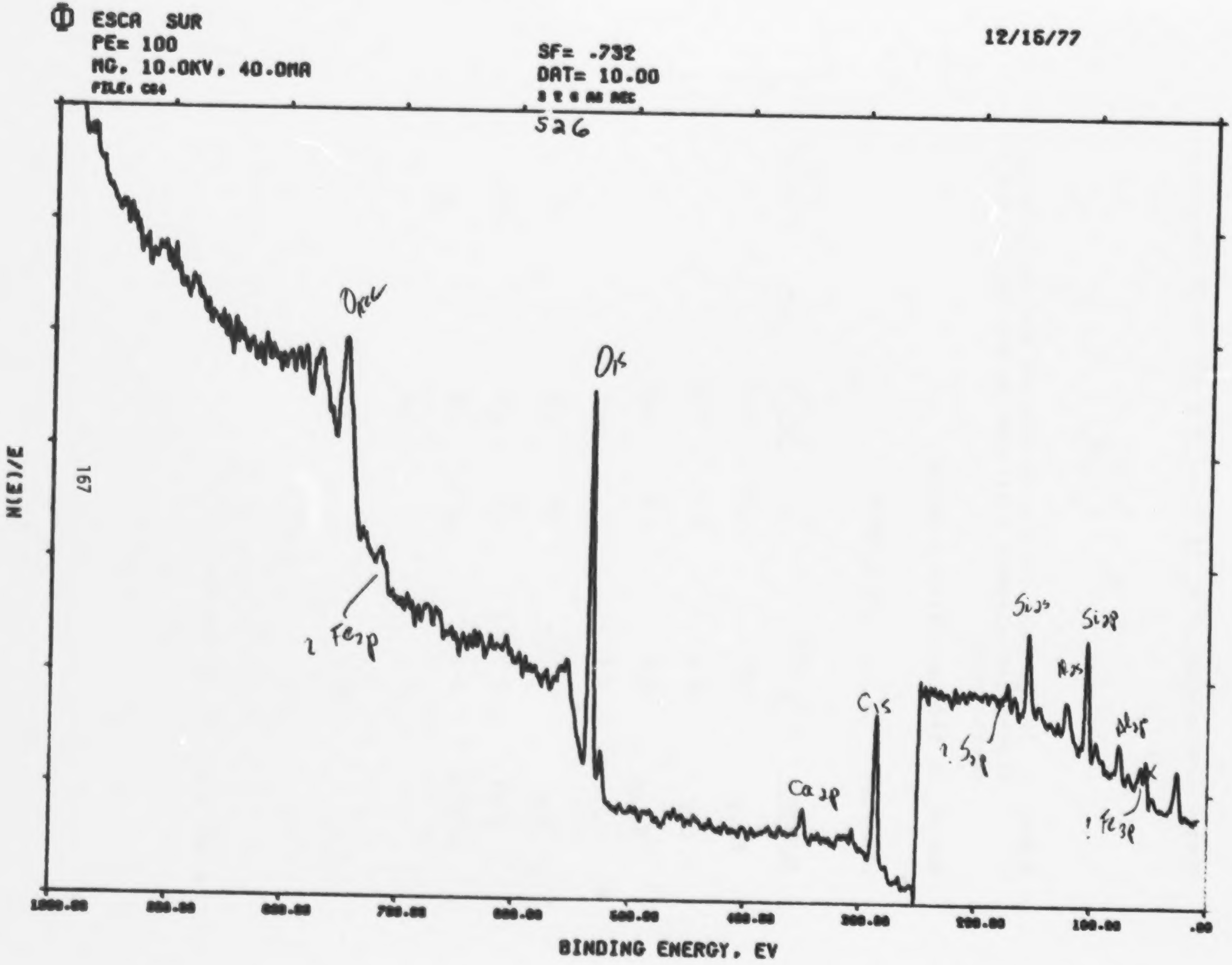
$$C_x = \frac{I_x/S_x}{\Sigma_\alpha I_\alpha/S_\alpha}$$

Where, I_x is the peak-to-peak height of the Auger electron signal for element X divided by the proper scale sensitivity

and S_x is the sensitivity factor

EXAMPLE: S 25 AFTER 100Å ETCH (Ar^+)

ELEMENT	I_x (Cm)	S_x	I_x/S_x	C_x	Atom Percent
Fe_{2p}	0.7	1.55	0.5		3
O_{1s}	5.0	.63	7.9		54
Ca_{2p}	0.4	.71	0.6		4
* C_{1s}	2.0	—			
Na_{1s}	0.1	2.54	.04		.03
S_{2p}	—	.28	—		
Si_{2s}	1.3/4	.104	3.1		21
Al_{2s}	1.0/4	.095	2.6		18
			14.7		


ESCA SUR
PE= 100
MG. 10.0KV. 40.0MA
FILE: C84
SF= .732
DAT= 10.00
[illegible]
12/15/77
526
OKLL
O1s
? Fe2p
Ca2p
C1s
? S2p
Si2s
Al2s
Si2p
Al2p
! Fe3p
N(E)/E
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
.00
BINDING ENERGY, EV

Atomic concentration C_x of element X may be estimated by

$$C_x = \frac{I_x/S_x}{\Sigma_\alpha I_\alpha/S_\alpha}$$

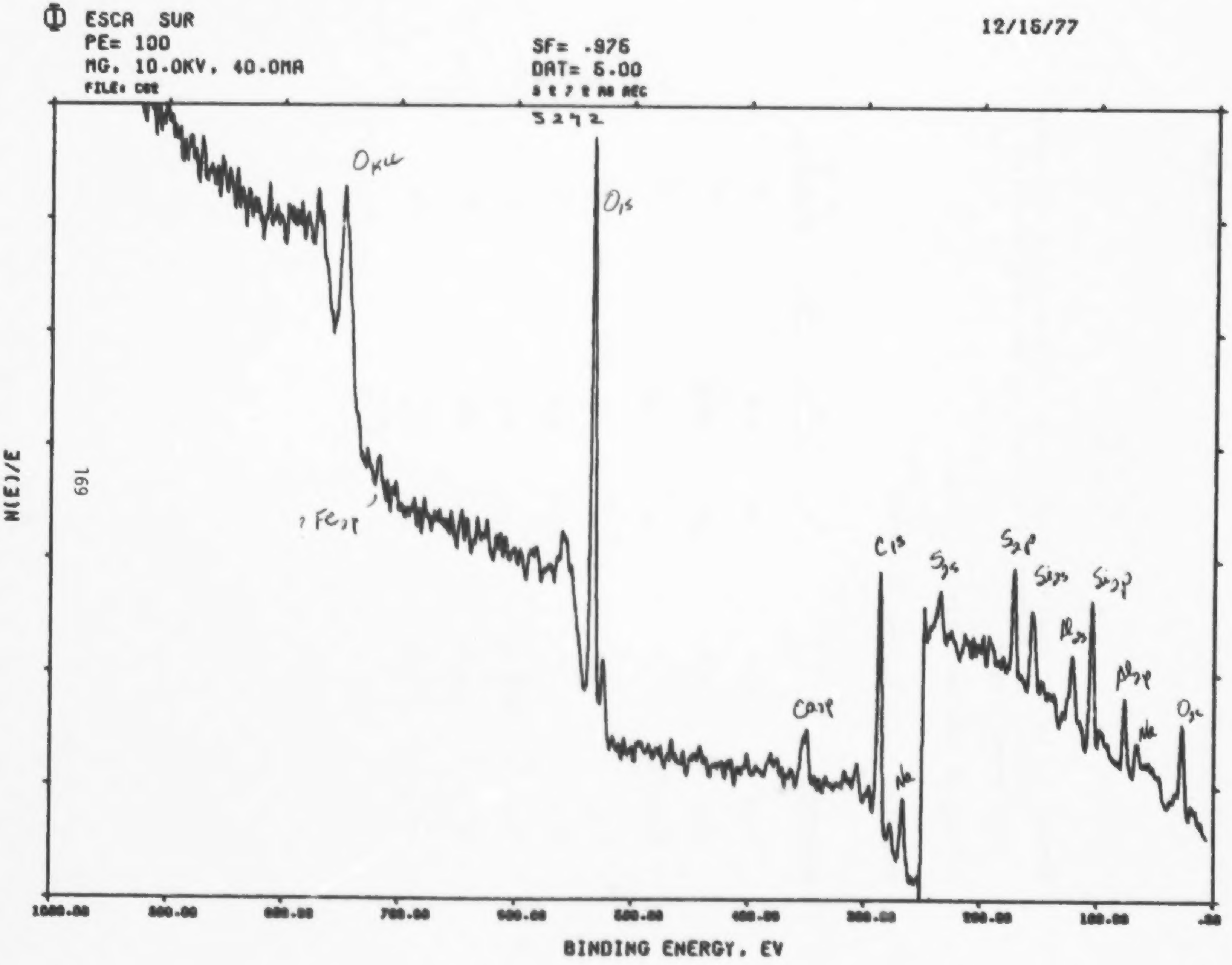
Where, I_x is the peak-to-peak height of the Auger electron signal for element X divided by the proper scale sensitivity

and S_x is the sensitivity factor

EXAMPLE: S 26 AS RECEIVED

ELEMENT	I_x (Cm)	S_x	I_x/S_x	C_x	Atom Percent
Fe_{2p}	0.7	1.55	0.5		2
O_{1s}	8.5	0.63	13.5		62
Ca_{2p}	0.6	0.71	0.8		4
* C_{1s}	3.3	–	–		
S_{2p}	0.5/4	.28	0.4		2
Si_{2s}	2.0/4	.104	4.8		22
Al_{2s}	0.7/4	.095	1.8		8
			21.8		

* NOT USED IN % CALCULATION


ESCA SUR
PE= 100
MG, 10.0KV, 40.0MA
FILE: C0R
SF= .976
DAT= 5.00
3 2 7 2 A0 REC
5272
12/15/77
N(E)/E
BINDING ENERGY, EV
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
.00
O$_{KLL}$
?Fe$_{2p}$
O$_{1s}$
Ca$_{2p}$
C$_{1s}$
Na
S$_{2s}$
S$_{2p}$
Si$_{2s}$
Si$_{2p}$
Al$_{2s}$
Al$_{2p}$
Na
O$_{2s}$

Atomic concentration C_x of element X may be estimated by

$$C_x = \frac{I_x/S_x}{\Sigma_\alpha I_\alpha/S_\alpha}$$

Where, I_x is the peak-to-peak height of the Auger electron signal for element X divided by the proper scale sensitivity

and S_x is the sensitivity factor

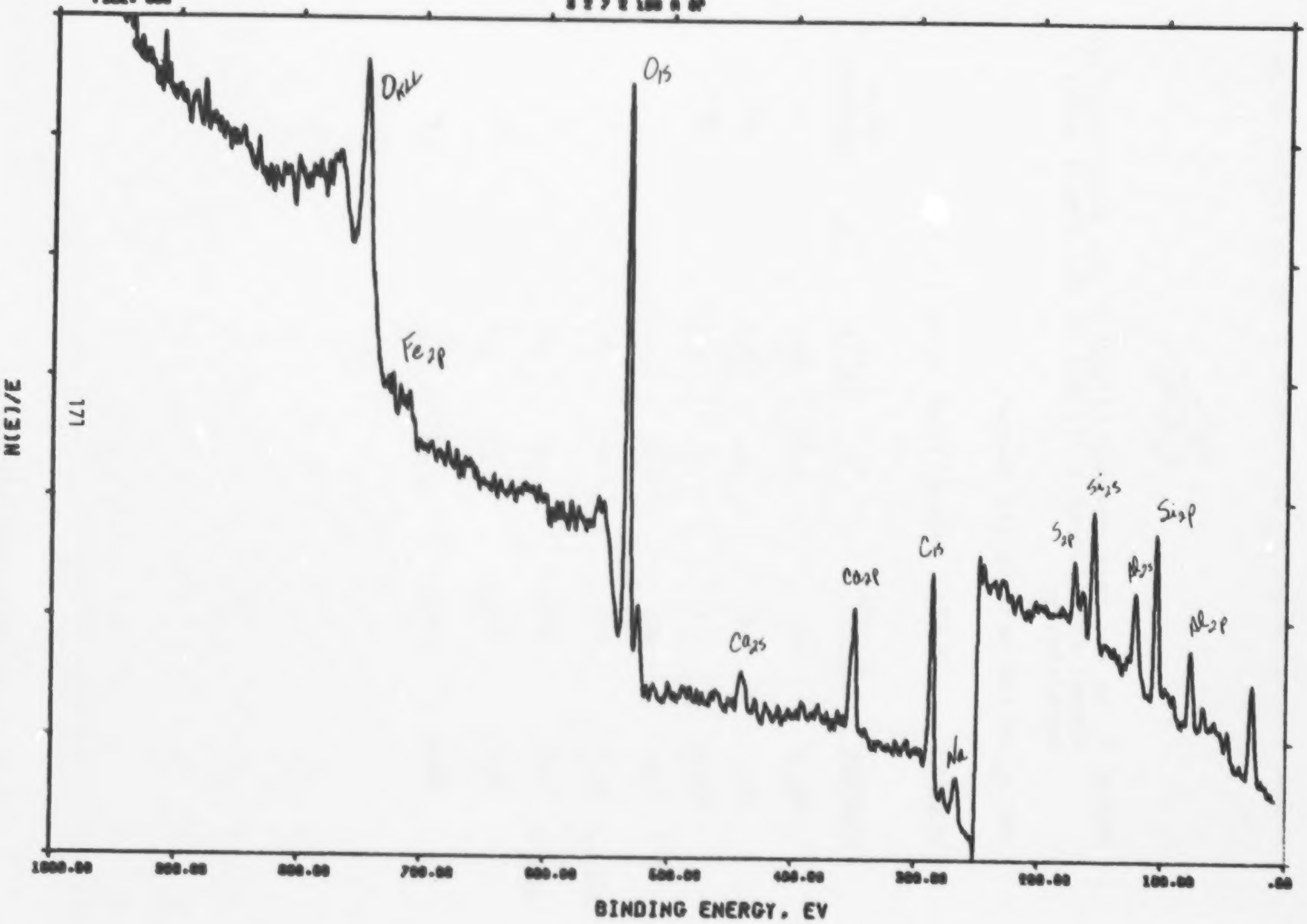
EXAMPLE: 5272 As Received

ELEMENT	I_x (Cm)	S_x	I_x/S_x	C_x	Atom Percent
Fe_{2p}	0.6	1.55	0.4		1
O_{1s}	12.2	.63	19.4		61
Ca_{2p}	1.2	.71	1.7		5
* C_{1s}	5.5	.205	-		-
Na_{1s}	1.3	2.54	0.5		2
Al $SO_4^{=}$ - S_{2p}	2.4/4	.28	2.1		7
Si_{2s}	1.7/4	.104	4.1		13
Al_{2s}	1.4/4	.095	3.7		12
			31.9		

ESCA SUR
PE= 100
MG. 10.0KV. 40.0MA
FILE: C08

SF= 1.466
DAT= 6.00
8 2 7 2 100 A 0P

12/15/77



Atomic concentration C_x of element X may be estimated by

$$C_x = \frac{I_x/S_x}{\Sigma_a I_a/S_a}$$

Where, I_x is the peak-to-peak height of the Auger electron signal for element X divided by the proper scale sensitivity

and S_x is the sensitivity factor

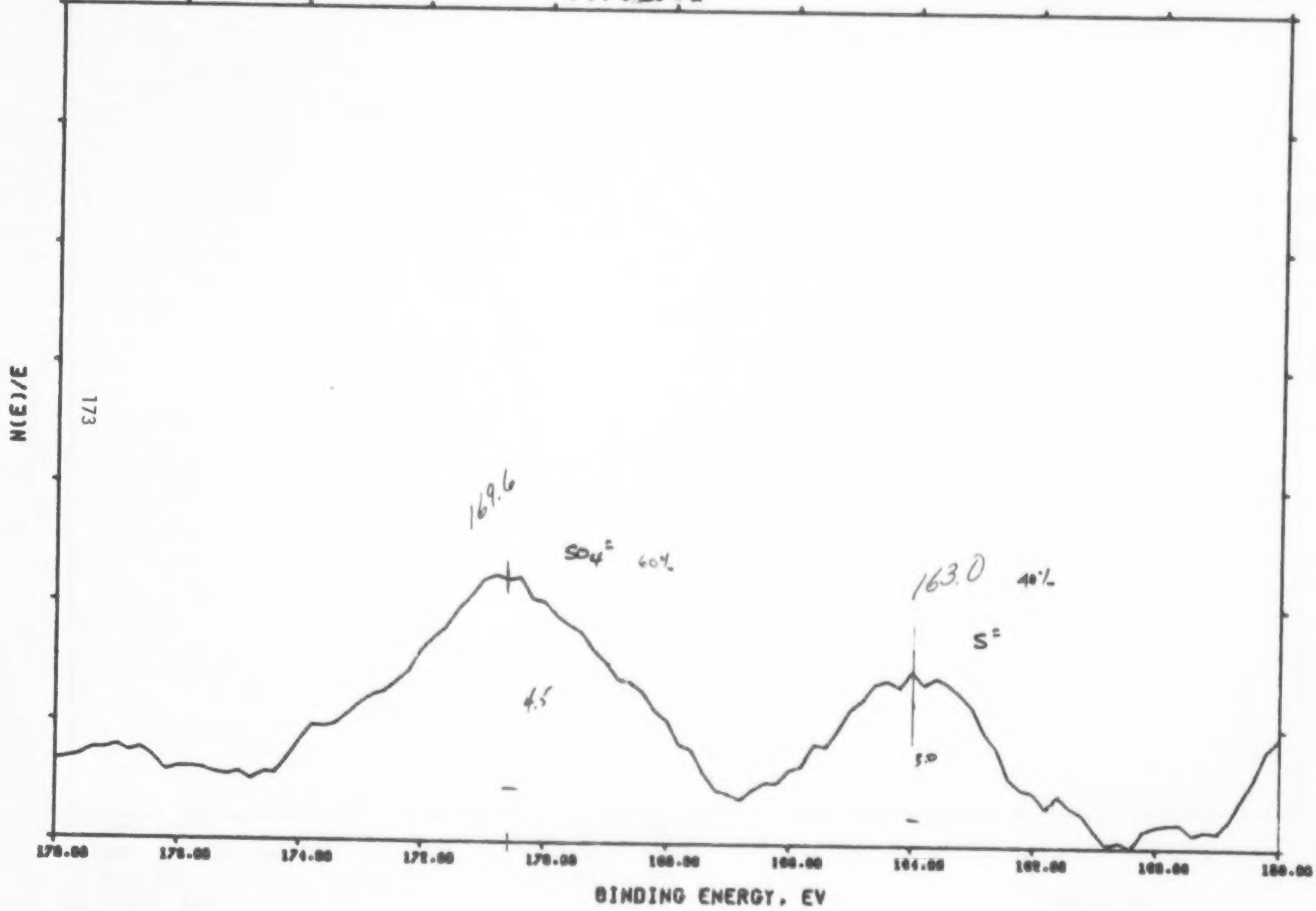
EXAMPLE: S272 AFTER 100Å ETCH (Ar^+)

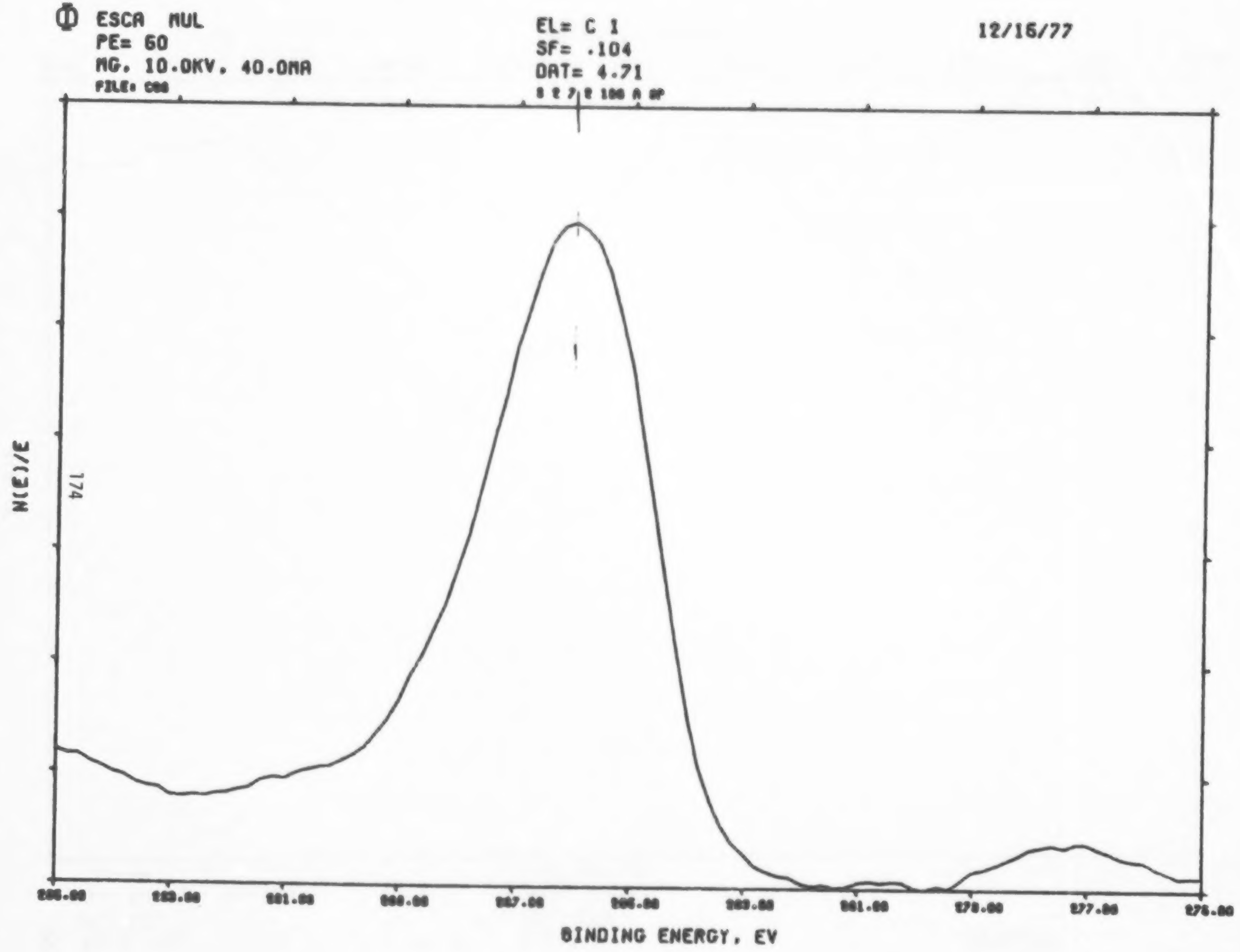
	ELEMENT	I_x (Cm)	S_x	I_x/S_x	C_x	Atom Percent
	Fe_{2p}	0.3	1.55	0.2		1
	O_{1s}	11.5	.63	18.2		53
	Ca_{2p}	2.5	.71	3.5		10
*	C_{1s}	4.3	.205	-		
60% $SO_4^{=}$	Na_{1s}	0.6	2.54	.2		1
40% $S^{=}$	S_{2p}	1.9/4	.28	1.7		5
	Si_{2s}	2.3/4	0.104	5.5		16
	Al_{2s}	1.9/4	0.095	5.0		15
				34.3		

Φ ESCA MUL
PE= 50
MG. 10.0KV. 40.0MA
FILE: C00

EL= S 1
SF= .016
DAT= 17.67
8 2 7 2.100 A SP

12/15/77

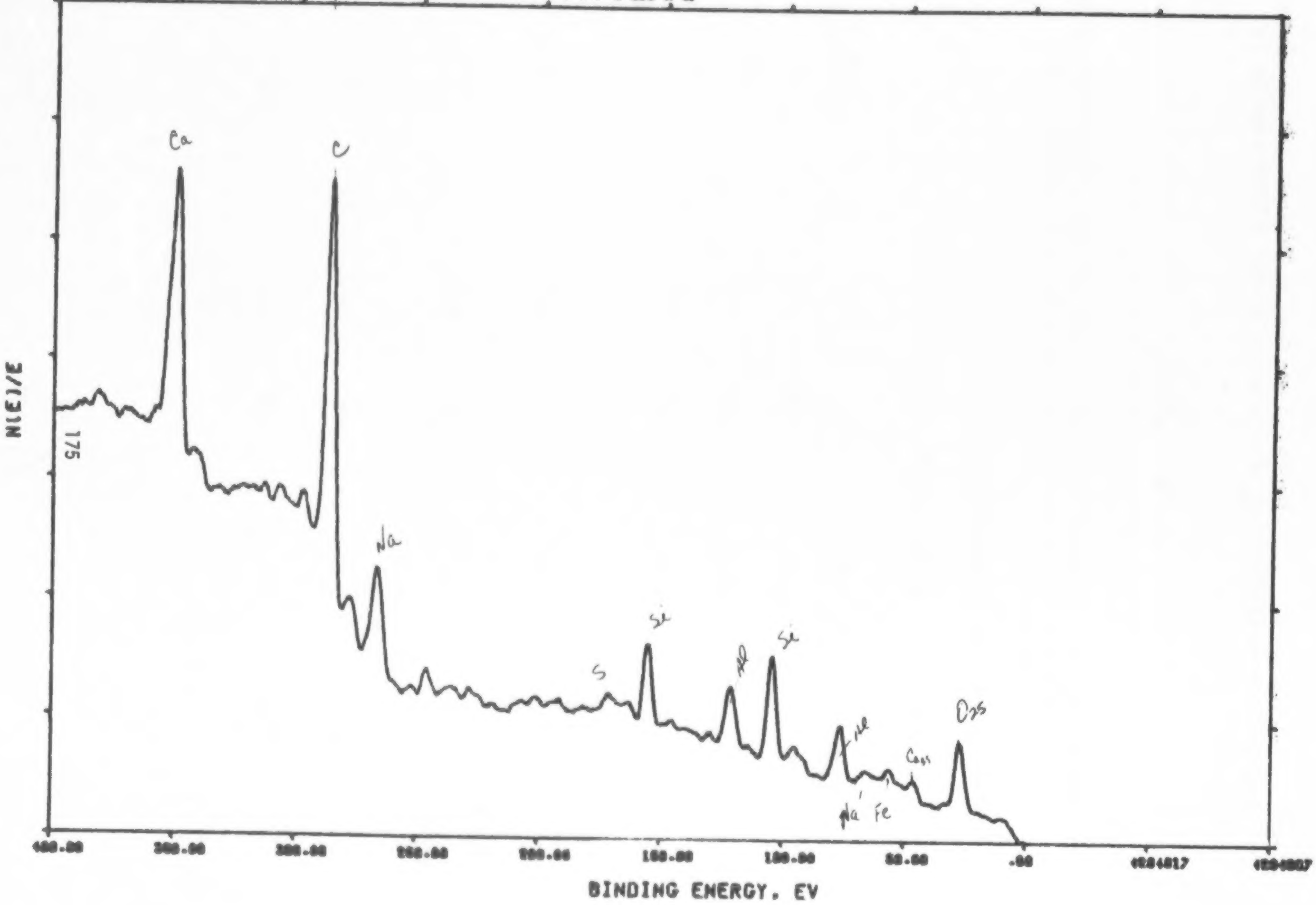



ESCA MUL
PE= 60
MG, 10.0KV, 40.0MA
FILE: C08
EL= C 1
SF= .104
DAT= 4.71
12/16/77
N(E)/E
277.00
276.00
BINDING ENERGY, EV

Φ ESCA SUR
PE= 100
MG, 10.0KV, 40.0MA
FILE: 3 2 7

SF= .487
DAT= 16.02
3 2 7 2 200 A 3P

12/15/77



Atomic concentration C_x of element X may be estimated by

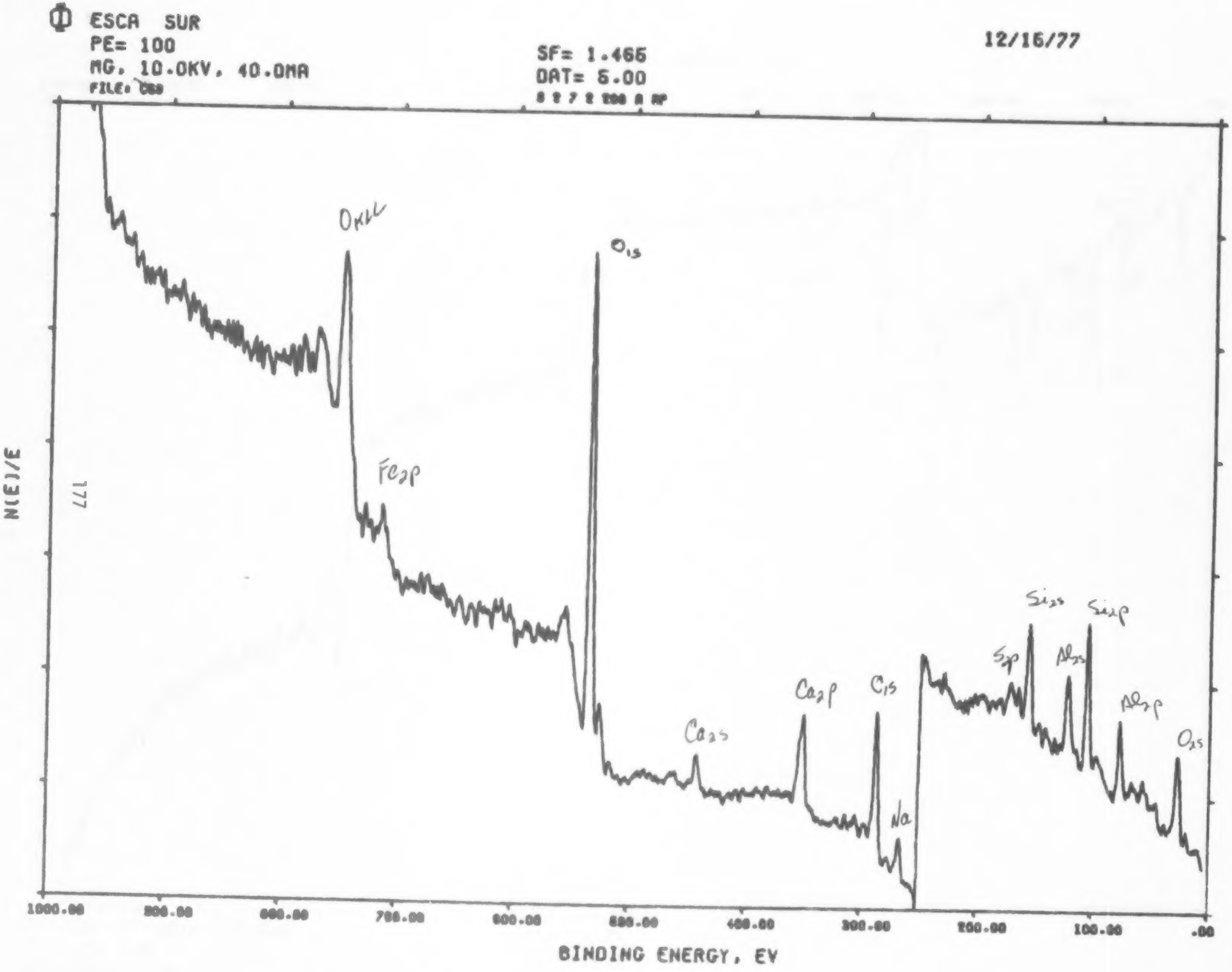
$$C_x = \frac{I_x/S_x}{\Sigma_\alpha I_\alpha/S_\alpha}$$

Where, I_x is the peak-to-peak height of the Auger electron signal for element X divided by the proper scale sensitivity

and S_x is the sensitivity factor

EXAMPLE: 5272 AFTER 200 Å ETCH (Ar^+)

ELEMENT	I_x (Cm)	S_x	I_x/S_x	C_x	Atom Percent
Fe_{2p}	0.9	1.55	.58		2
O_{1s}	10.5	.63	16.7		53
Ca_{2p}	2.0	.71	2.8		9
* C_{1s}	2.9	.205	-		—
Na_{1s}	0.8	2.54	0.3		1
55% $SO_4^=$ 45% $S^=$ } S_{2p}	1.1 /4	.28 ~~.104~~	1.0		3
Si_{2s}	2.2 /4	.104	5.3		17
Al_{2s}	1.7 /4	0.[illegible]95	4.5		14
			31.2		

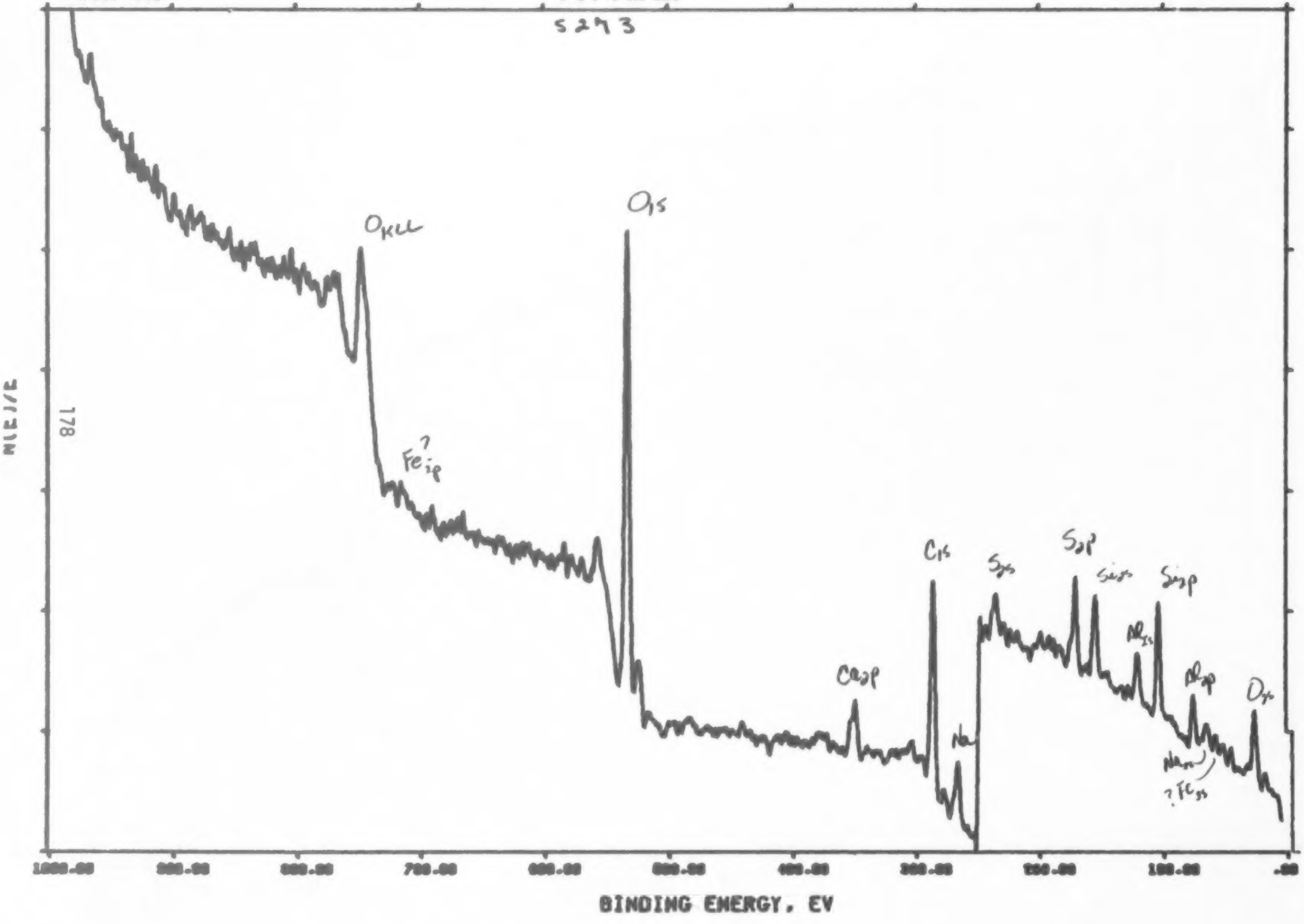

Φ ESCA SUR
PE= 100
MG, 10.0KV, 40.0MA
FILE: C80
SF= 1.466
DAT= 5.00
12/16/77
N(E)/E
BINDING ENERGY, EV
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
.00
OKLL
Fe2p
O1s
Ca2s
Ca2p
C1s
Na
S2p
Si2s
Al2s
Si2p
Al2p
O2s

Φ ESCA SUR
PE= 100
MG. 10.0KV, 40.0MA
FILE: C01

SF= 1.466
DAT= 5.00
5 2 7 3 AS REC

12/16/77

5273



Atomic concentration C_x of element X may be estimated by

$$C_x = \frac{I_x/S_x}{\Sigma_\alpha I_\alpha/S_\alpha}$$

Where, I_x is the peak-to-peak height of the Auger electron signal for element X divided by the proper scale sensitivity

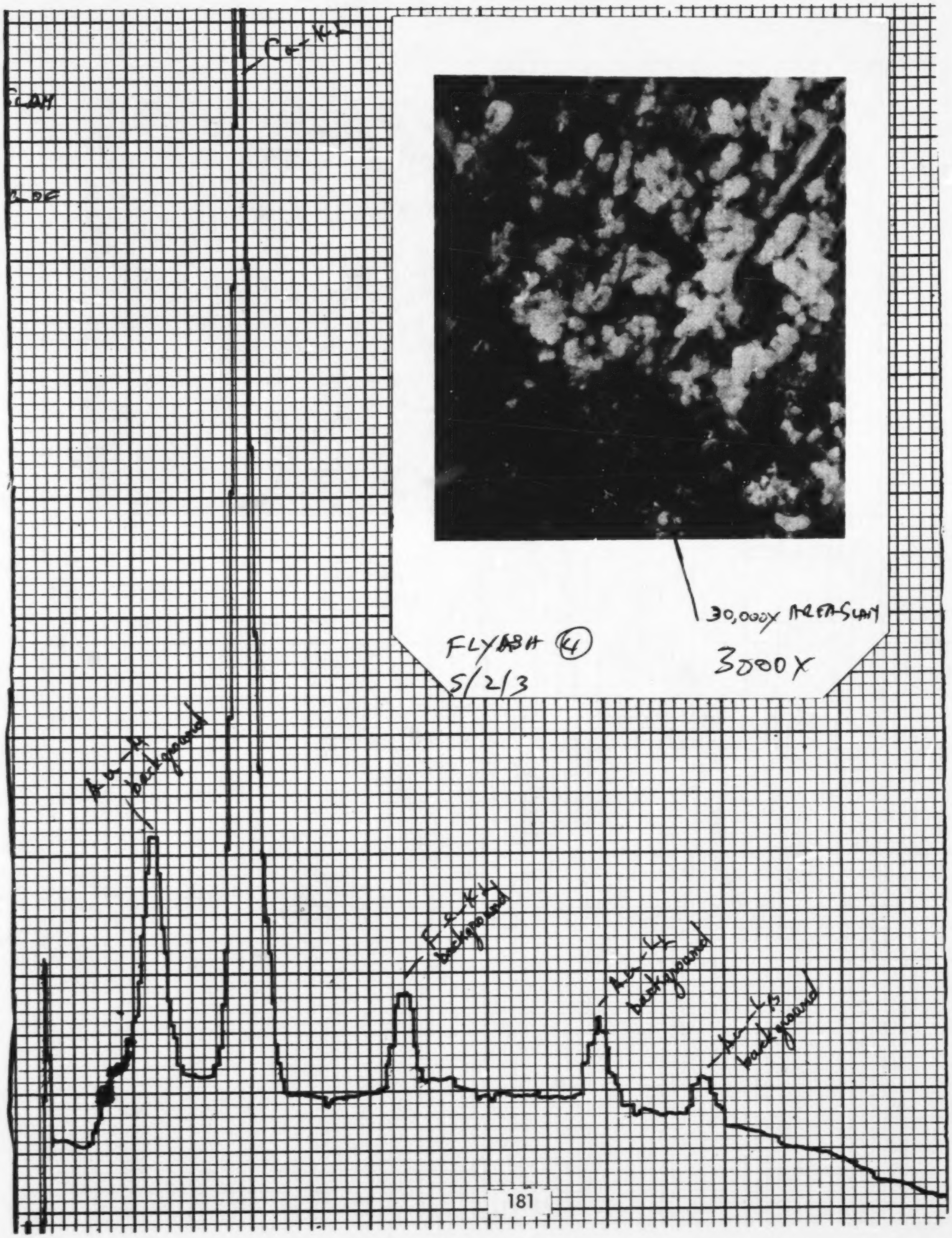
and S_x is the sensitivity factor

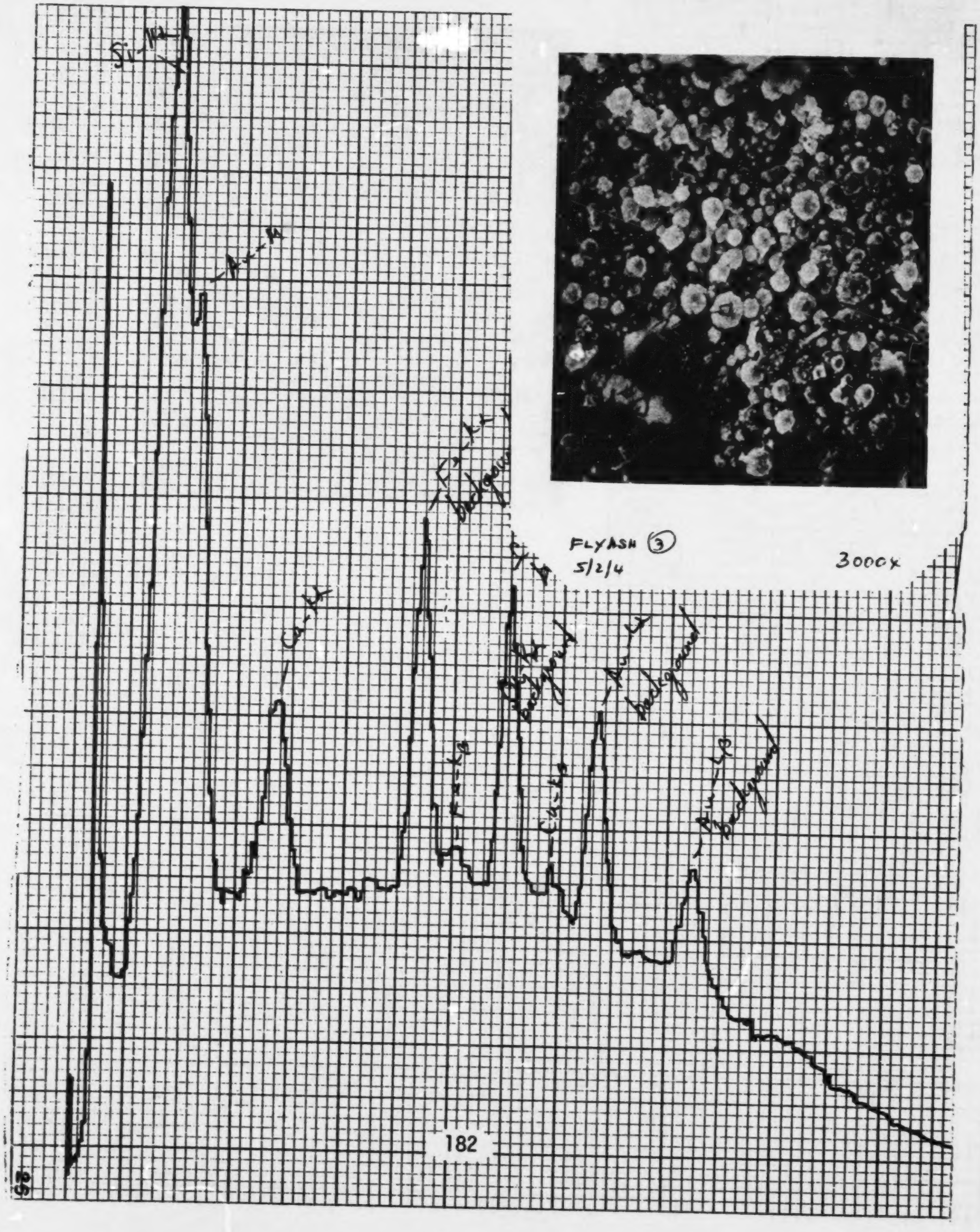
EXAMPLE: S 273 AS RECEIVED

ELEMENT	I_x (Cm)	S_x	I_x/S_x	C_x	Atom Percent
Fe_{2p}	0.4	1.55	0.3		1
O_{1s}	9.5	.63	15.1		59
Ca_{2p}	1.2	.71	1.7		7
* C_{1s}	4.4	–	–		–
Na_{1s}	1.2	2.54	0.5		2
S_{2p}	1.9/4	.28	1.7		7
Si_{2s}	1.6/4	.104	3.8		15
Al_{2s}	0.9/4	.095	2.4		9
			25.5		

APPENDIX D

SEM-EDX SCANS


Ca-Kα
Au-Mα background
Fe-Kα background
Au-Lα background
Au-Lβ background
30,000X AREA-SCAN
FLYASH ④
5/2/3
3000X



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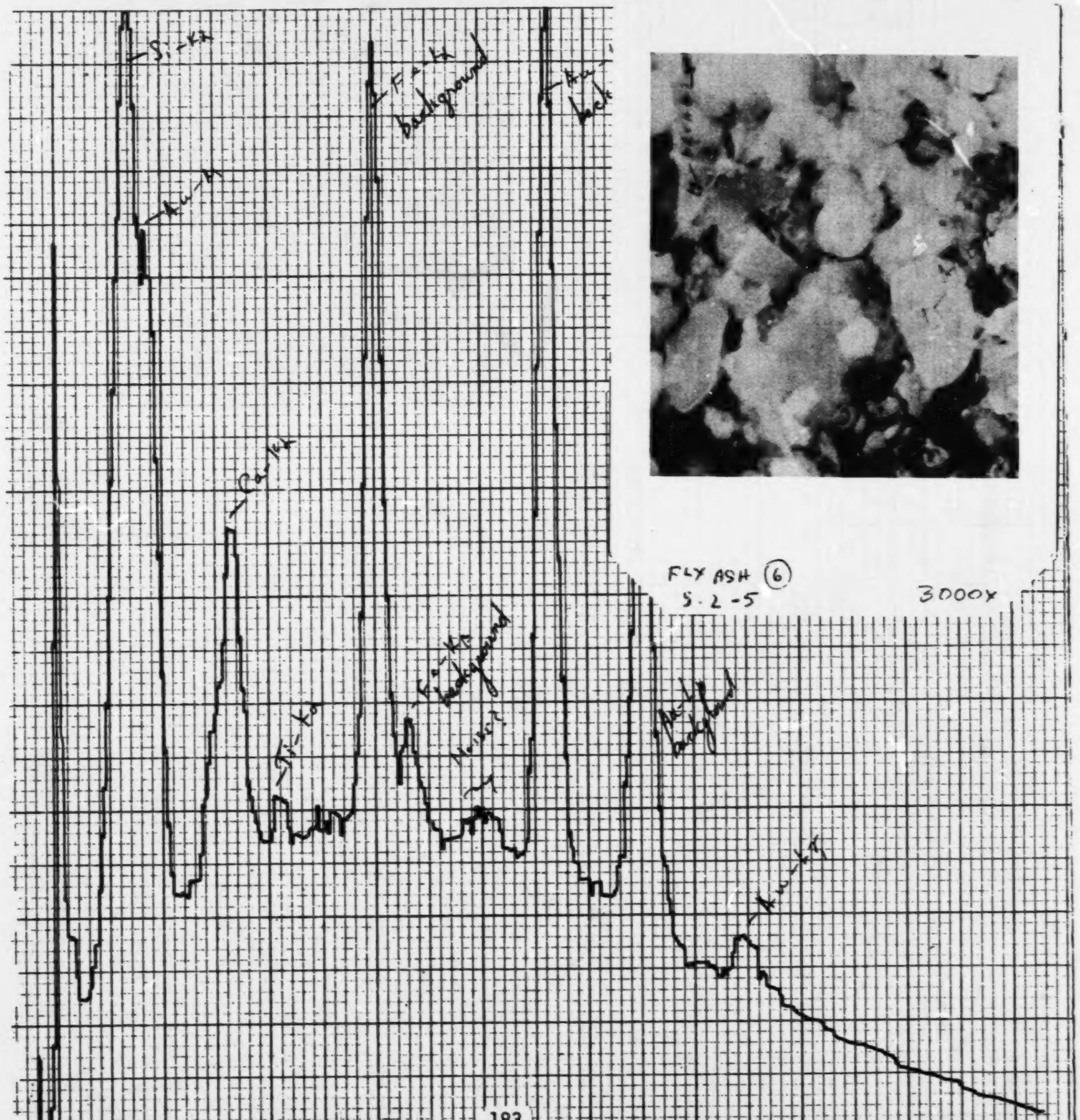

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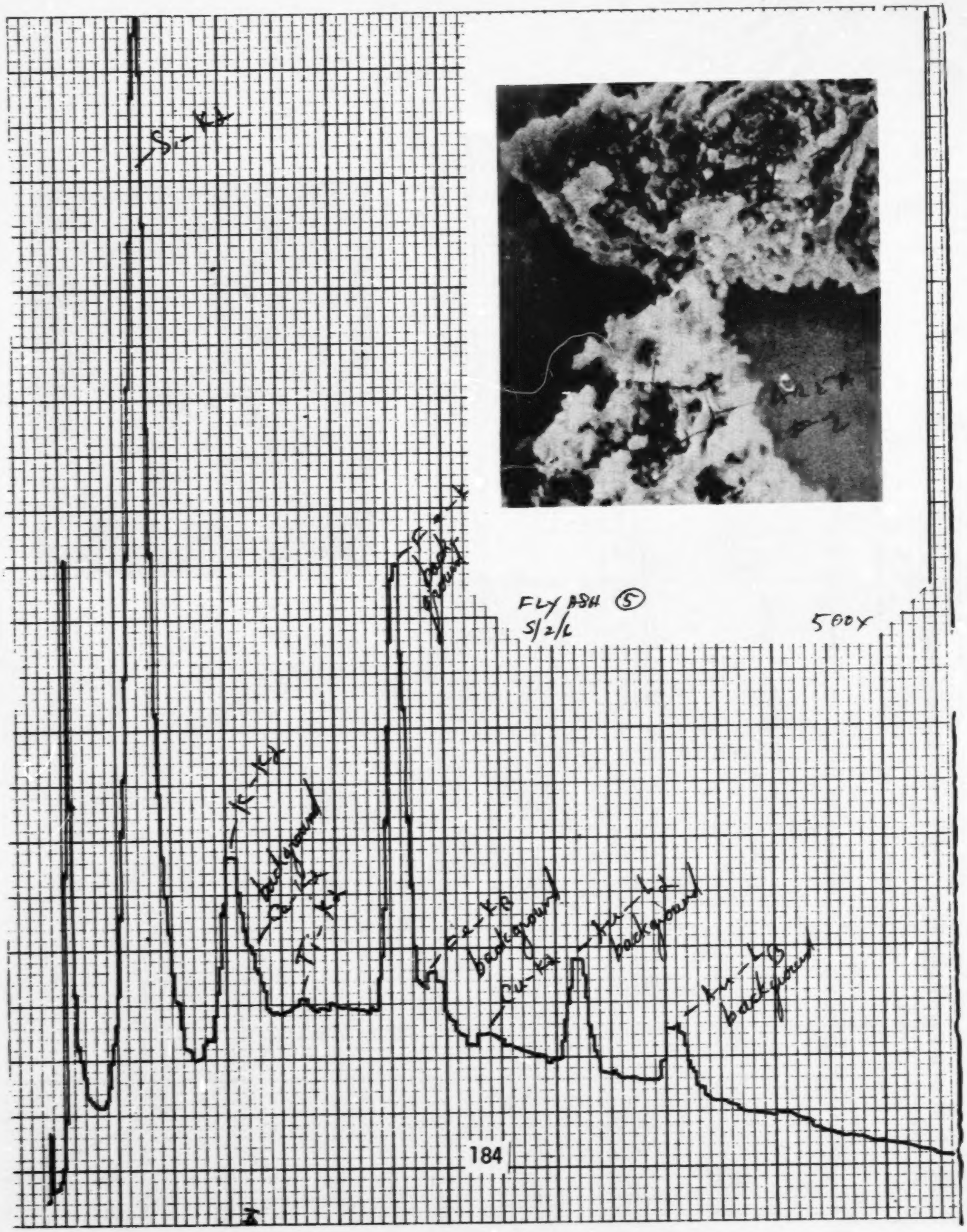

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5/2/6

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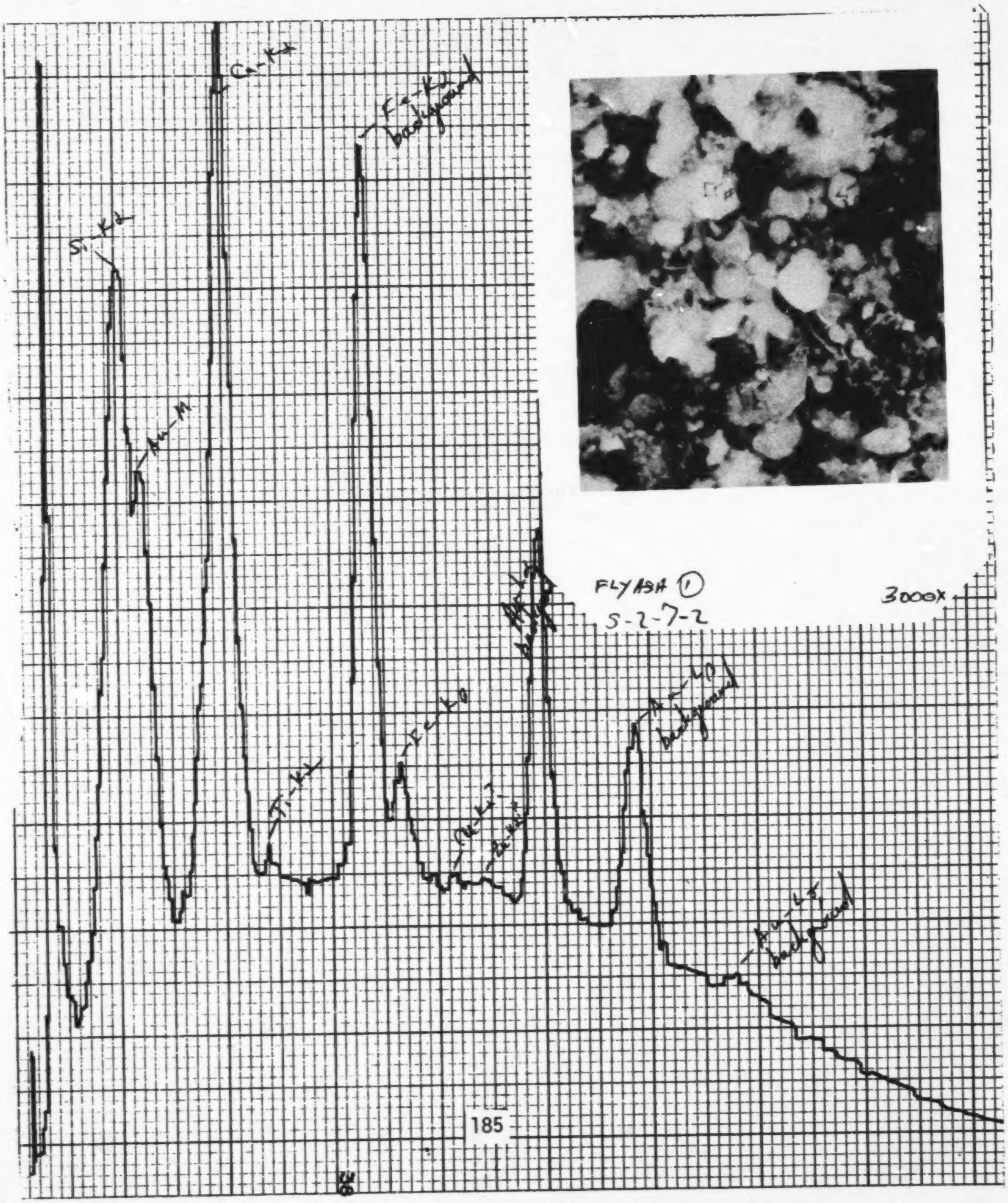

FLY ASH ①
S-2-7-2
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APPENDIX E

LEVEL 1 ORGANIC DATA

The sample aliquots were weighed into pre-extracted (24 hours in nanograde methylene chloride) Whatman No. 41 filter paper and then placed in the soxhlet glass extraction thimbles and extracted for 24 hours in nanograde methylene chloride. Procedural blanks consisted of: (1) the soxhlet apparatus with a pre-extracted filter paper and (2) an NBS inorganic Standard Fly Ash handled identically to the Battelle FBC particulates. The sample organic extracts were then measured (volume) and allocated following Figure 3-2. Two milliliters were removed before sample concentration: one for GC and determination of the volatile organic components and one for Level 2 Gas Chromatography Mass Spectrometry (GCMS). The remaining organic extracts were then concentrated using a Kuderna-Danish apparatus to 10 milliliters. One milliliter was disbursed for gravimetric and IR analysis and one milliliter was retained for Level 2 GCMS. Eight milliliters were then separated by Liquid Chromatography (LC). Two milliliters of each LC fraction were retained for Level 2 GCMS. The remaining LC fractions were characterized by gravimetric and Infrared Spectroscopic Analysis. Low Resolution Mass Spectroscopy was conducted on neat sample extracts and is reported in Section 3.

E.1 Gas Chromatographic Analysis

The gas chromatography (GC) analyses were performed using a Varian 1860 chromatograph with dual differential flame ionization detectors. The operating parameters were as follows:

- Column — 3.0% SE-30 on Chromosorb WHP, 100/120 mesh, 0.32 x 183 stainless steel.
- Flow rates — column, 20 ml/min He; detectors, 300 ml/min air 30 ml/min H_2.
- Temperatures — detectors, 300°C; injectors, 200°C; column, begin and hold at ambient for 5 min, then program temperature increase from 30°C to 110°C at 10°C/min.
- Electrometer — 1×10^{-10} A/mV.
- Recorder — 1 mV full scale.
- Injections — 1μl

These settings and conditions provide a lower detectable limit of 0.7 ng/µl for n-alkanes. This would be equivalent to a component concentration of approximately 2 x 10^{-4} mg/m^3 in the sample gas, which is much below the 0.5 mg/m^3 level of interest in the Level 1 Manual. However, this is not below some of the MATE concentrations. Therefore, an organic extract aliquot will be analyzed by the more sensitive GCMS technique. The instrument was calibrated and analytical results are expressed in terms of the quantity of n-alkanes boiling in the following temperature ranges:

• C7	90-110°C
• C8	110-140°C
• C9	140-160°C
• C10	160-180°C
• C11	180-200°C
• C12	200-220°C

To calibrate the instrument for these C7-C12 boiling point ranges, chromatograms of n-alkane mixtures - C5-C9 and C8-C12 - were obtained and a plot of normal boiling points versus retention times was constructed as shown in Figure E-1. The retention times corresponding to the appropriate boiling ranges were then determined from this plot. Peak areas on chromatograms of samples were summed within each retention time interval in order to convert to quantities of components designated as n-alkanes.

To quantitate the peak areas of actual sample chromatograms, a n-decane standard was prepared containing 715.6 ng/µl. Two serial tenfold dilutions were made to prepare standards containing, respectively, 71.56 and 7.156 ng/µl. A plot of response in µV·sec for replicate injections as compared with concentration in ng/µl was calculated and is shown in Figure E-2. A linear regression analysis of the data yields a slope of 78.21 µV · sec · µl/ng and an intercept at 70.4 µV · sec.

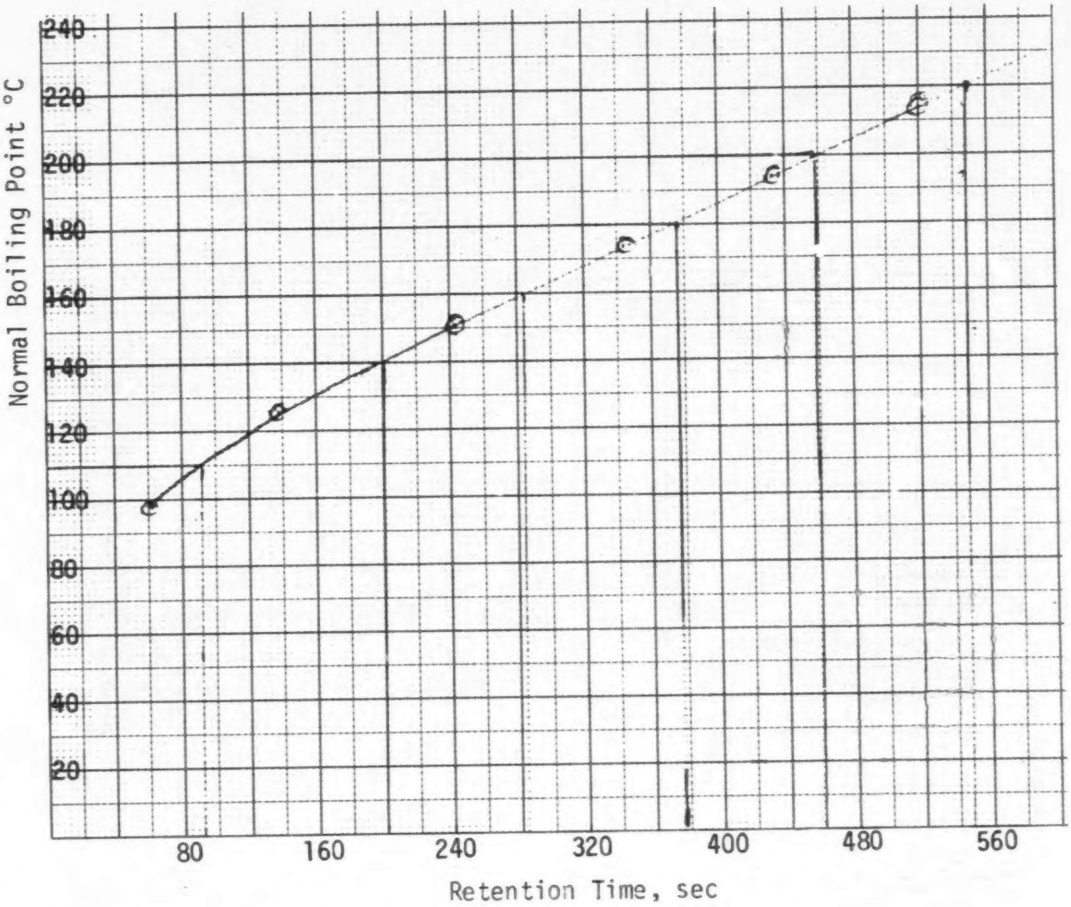


Figure E-1. Retention Time Versus Normal Boiling Point

The slope of the plot is the sensitivity of the analysis for n-decane. A plot of molar response versus carbon number for a homologous series yields a straight line. Therefore, if the weight response of n-decane is converted to molar response, the molar responses to the n-C_7 to n-C_{12} hydrocarbons can be calculated. The calculated molar responses are as follows:

n-C_7 = 7.79×10^{12} μV·sec·μl/mole
n-C_8 = 8.90×10^{12}
n-C_9 = 1.00×10^{13}
n-C_{10} = 1.11×10^{13}
n-C_{11} = 1.22×10^{13}
n-C_{12} = 1.34×10^{13}

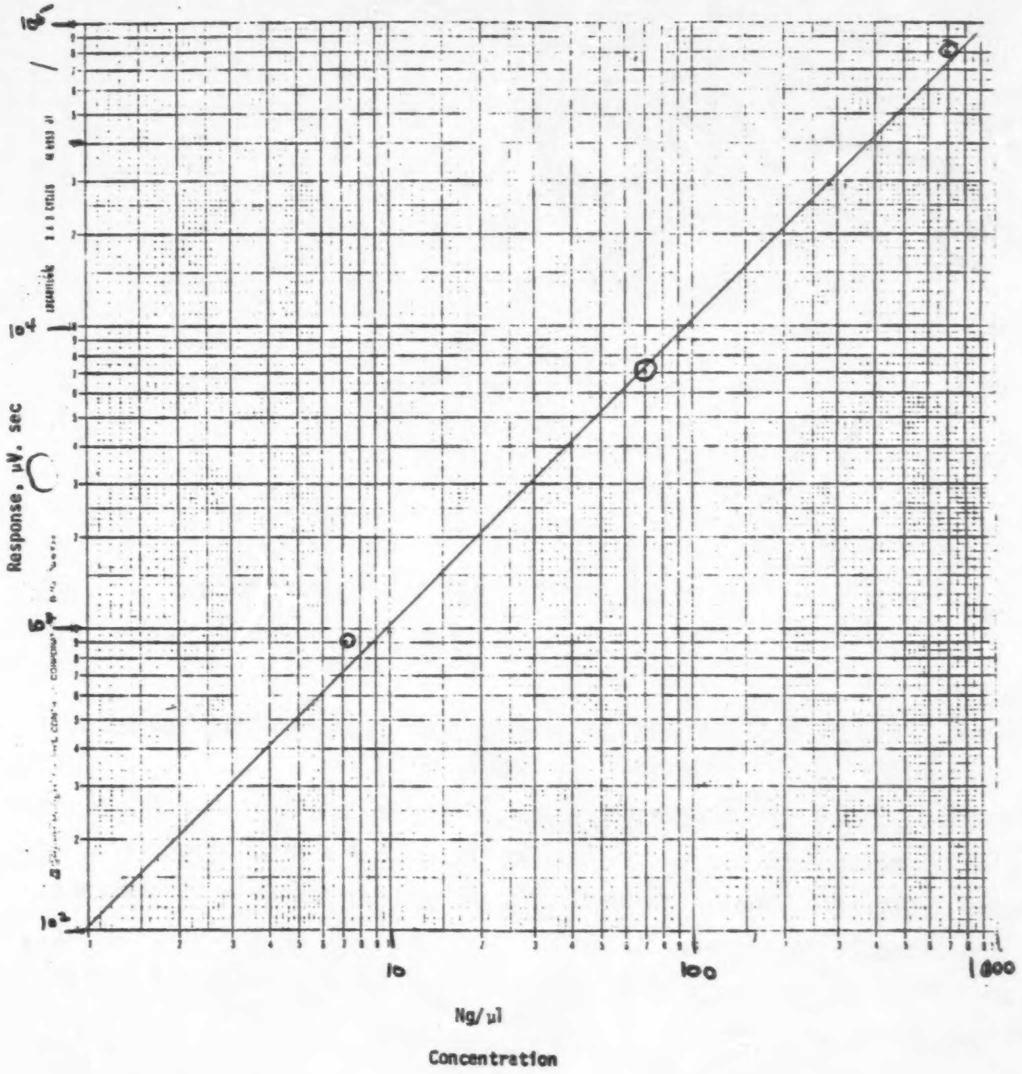


Figure E-2. Response Versus Concentration

The weight responses (molar responses divided by molecular weight) are then calculated:

n-C_7 = 77.74 μV·sec·μl/ng
n-C_8 = 77.94
n-C_9 = 78.09
n-C_{10} = 78.21
n-C_{11} = 78.31
n-C_{12} = 78.40

Quantitation is then accomplished by converting areas in the appropriate retention time intervals to concentrations by using the appropriate sensitivities. The total amount of material in each sample is determined by multiplying the concentration by the sample volume and the fraction of sample extracted. Concentration in the gaseous emissions is then determined by dividing the weight of material in the sample extract by the volume of gas sampled. The results of these analyses are given in Table E-1.

These data are reported on the Level 1-Level 2 data presentation charts under "SASS, LAB, C7 - SASS, LAB, C12." These are the Level 1 reporting points for the volatile organic species.

E.2 Gravimetry for C_{13} and Higher Hydrocrabons

Gravimetric determinations were performed on the concentrates methylene chloride extracts in accordance with the procedure in the Level 1 Manual. All concentrations were performed with Kuderna-Danish evaporators.

One milliliter aliquots were taken from each of the 10 ml volume concentrates and evaporated to dryness in aluminum pans. The residues were then weighed on a microbalance. The results are presented in Table E-1. These data give the total nonvolatile, >C13, organic content of the samples.

Table E-1. Level 1 Data on Run No. 2 FBC Sample

Sample Code Weight of Sample Extracted (Emission Rate Factor)		C7-17 Gas Chromatographic* Data							>13 Weight Data	LC Fractionation Data								μg Recovery From LC	% Recovery From LC
		C7	C8	C9	C10	C11	C12	C13		LC1	LC2	LC3	LC4	LC5	LC6	LC7	LC8		
S-2-3 9.820 (48.8)	μg μg/g μg/m^3	0	0	0	0	0	0	0	640.0 64.1 3,128.1	0	300.0 30.0 1,467.0	0	0	0	300.0 30.0 1,467.0	500.0 50.0 2,444.0	200.0 20.0 978.0	1,300.0	203.0
S-2-4 0.3650 (0.095)	μg μg/g μg/m^3	0	0	300.0 822.0 78.0	80.0 219.0 21.0	0	0	0	730.0 2,000.0 190.0	0	0	0	200.0 549.0 52.0	200.0 549.0 52.0	500.0 183.0 17.0	800.0 2,192.0 208.0	100.0 274.0 26.0	1,800.0	246.0
S-2-5 3.9652 (1.53)	μg μg/g μg/m^3	0	0	0	66.0 16.6 25.5	0	0	0	21,110.0 5,323.0 8,145.5	1,650.0 416.0 637.0	0	1,800.0 454.0 695.0	1,100.0 277.4 424.2	1,100.0 277.4 424.2	3,000.0 757.0 1,157.6	400.0 101.0 154.3	1,700.0 429.0 656.4	10,750.0	51.0
S-2-6 3.9355 (18.5)	μg μg/g μg/m^3	0	0	0	0	0	0	0	950.0 241.4 4,466.0	0	100.0 25.4 470.0	0	300.0 76.3 1,410.0	0	200.0 50.8 940.0	100.0 25.4 470.0	100.0 25.4 470.0	800.0	84.2
S-2-7 0.5335 (0.16)	μg μg/g μg/m^3	0	0	0	0	0	0	0	990.0 1,856.0 297.0	0	400.0 750.0 120.0	200.0 375.0 60.0	100.0 187.0 30.0	0	800.0 1,500.0 240.0	0	0	1,500.0	152.0
S-2-1 4.0138 (NO RATE DATA)	μg μg/g μg/m^3	0	18,136.0 4,518.0	0	0	0	0	0	70,810.0 17,642.0	8,000.0 1,993.0	2,200.0 548.0	3,000.0 747.4	4,800.0 1,196.0	5,200.0 1,296.0	11,200.0 2,790.0	300.0 74.7	1,300.0 324.0	36,000.0	51.0
S-2-2 3.9991 (NO RATE DATA)	μg μg/g μg/m^3	0	0	0	0	0	0	0	140.0 35.0	NOT CONDUCTED/SAMPLE SIZE NOT ADEQUATE									
FLY ASH NBS #1633 3.9569	μg μg/g	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

*Only traces were found above C13.

E.3 Infrared Analysis

This procedure is used to determine the functional group types present in an organic sample or LC fraction of a partitioned sample. The IR data, when interpreted, provide information on functionality, e.g., carbonyl, aromatic hydrocarbon, alcohol, amine, aliphatic hydrocarbon, halogenated organic, etc. Compound information is possible only when that compound is known to be present as a dominant constituent in the sample. However,, such foreknowledge is normally unlikely.

Sample amounts required for this analysis are in the milligram (mg) range with a lower limit of approximately 0.5 mg. A compound must be present in the sample at about 5%-10% (w/w) or more in order for the stronger functional groups of the compound to become apparent for interpretive purposes. Organic solvents, water and some inorganic materials cause interferences. Water and other substances may also cause a decrease in the quality (e.g., resolution of a spectrum, sensitivity) of the analysis.

The initial organic sample or LC fraction, after evaporation, is either (1) taken up in a small amount of carbon tetrachloride or methylene chloride and transferred to a NaCl window, or (2) mixed with powdered KBr, ground to a fine consistency, and then pressed into a pellet. If a LRMS is to be run on the sample, it must be taken up in a solvent and an aliquot set aside for LRMS analysis. A grating IR spectrophotometer is used to scan the sample in the IR region from 2.5 to 25 microns. The spectrum is then interpreted to determine functional group types in the sample.

Table E-2 presents the spectral interpretations on the gravimetric residues of the $>$C13 aliquots and the LC fractions. The major, medium, minor and trace designations refer to the absorption band intensities. The interpretation has reported compound types/MEG categories rather than functionality, e.g., carbonyl. For example, in a case where only aliphatic hydrocarbon intensities are found in a spectrum and they are at a trace level, then the interpretation is only reported under that column heading.

Table E-2. Infrared Interpretation >C13 and LC Fractions Gravimetric Residue

Sample Code	Major	Medium	Minor	Trace
		S-2-1		
>C13	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	Water	Ester
LC 1	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	Water	Ester
LC 2	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	Water	Ester
LC 3	Aromatic Hydrocarbon	Halogenated Aromatic	Water	Ester
LC 4	Ether	Halogenated Aromatic	Water	Ester
LC 5	Phenol	Halogenated Aromatic	Water	Ester
LC 6	Phenol	Carboxylic Acid	Water	Ketone
LC 7	Carboxylic Acid	Phenol	Water	Ketone
LC 8	Water	Carboxylic Acid	Water	Ketone
Sample Code		S-2-2		
>C13	Aliphatic Hydrocarbon		Water	Ester
		LC Fractionation not conducted		
Sample Code		S-2-3		
>C13	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	Water	Ester
LC 1	-	-	-	-
LC 2	Ester, phthalate			
LC 3		NO INFRARED ACTIVITY		
LC 4	-	-	-	Aliphatic Hydrocarbon
LC 5	-	-	-	Aliphatic Hydrocarbon
LC 6	Acid, phthalate	-	-	-
LC 7	-	-	-	Aliphatic Hydrocarbon
LC 8	Water	Carboxylic Acid		-

Table E-2. Infrared Interpretation >C13 and LC Fractions Gravimetric Residue (Continued)

Sample Code	Major	Medium	Minor	Trace
		S-2-4		
>C13	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	Water	Ester
LC 1	-	-	-	
LC 2	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	-	-
LC 3	Aromatic Hydrocarbon	Aliphatic Hydrocarbon	-	Ester
LC 4	Ester	Halogenated Aromatic	-	Water
LC 5	Phenol	-	-	-
LC 6	Phenol	Carboxylic Acid	-	-
LC 7	Carboxylic Acid	Water	-	-
LC 8	Carboxylic Acid	Water	-	-
Sample Code		S-2-5		
>C13	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	Ester	Water
LC 1	-	-	-	-
LC 2	Aromatic Hydrocarbon	Halogenated Aromatic Hydrocarbons	-	-
LC 3	Aromatic Hydrocarbon	Ester	Halogenated Aromatic Hydrocarbons	-
LC 4	-	-	-	-
LC 5	Aromatic Hydrocarbon	Halogenated Aromatic Hydrocarbons	Ester	Carboxylic Acid
LC 6	Carboxylic Acid, Ester	Water	-	-
LC 7	Carboxylic Acid	Water	-	-
LC 8	Water	Carboxylic Acid	-	-

Table E-2. Infrared Interpretation >C13 and LC Fractions Gravimetric Residue (Continued)

Sample Code	Major	Medium	Minor	Trace
		S-2-6		
>C13	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	Ester	Water
LC 1	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	-	-
LC 2	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	-	-
LC 3	-	Halogenated Aromatic	-	-
LC 4	Ester	-	-	-
LC 5	Phenol	Ester	-	-
LC 6	Ester	Phenol	-	-
LC 7	Carboxylic Acid	Water	Ester	-
LC 8	Water	Carboxylic Acid	Ester	-
Sample Code		S-2-7		
>C13	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	Water	Ester
LC 1	Aliphatic Hydrocarbon	Aromatic Hydrocarbon	-	-
LC 2	-	Aromatic Hydrocarbon	-	-
LC 3	-	Aromatic Hydrocarbon	-	-
LC 4	-	-	-	Ester
LC 5	-	-	-	Aliphatic Hydrocarbon
LC 6	Ester, phthalate			
LC 7			NO INFRARED ACTIVITY	
LC 8			NO INFRARED ACTIVITY	
Sample Code			Fly Ash Standard, NBS #1633	
>C13	Ester	Water	NO INFRARED ACTIVITY IN LC FRACTIONS	-

E.4 Liquid Chromatographic Fractionation

The detailed procedure for the liquid chromatographic (LC) separation is given in Reference 1. All sample extracts and neat organic liquids are subjected to this procedure, if sample quantity is adequate. A 100 mg portion of the sample is preferred for the LC, but smaller quantities down to a lower limit of about 8 mg may be used. The sample is separated into approximate classes on silica gel using a gradient elution technique. The solvent sequence used for the procedure is given in Table E-3.

The LC separation procedure is not a high resolution technique and consequently there is overlap in class type between many of the fractions. Fraction 1 contains only the paraffins and possibly some olefins. Fractions 2 through 4 contain predominantly aromatic species. The smaller aromatics (benzene, naphthalene) will tend to elute in the early fraction (2) while the larger aromatics (benzopyrene, etc.) will tend to elute in Fractions 2 through 4. Some low polarity oxygen and sulfur containing species may also elute in Fraction 4 but most of these will not elute until addition of methanol.

Table E-3. Solvents Used in Liquid Chromatographic Separations

Fraction No.	Solvent Composition
1	Pentane
2	20% Methylene Chloride in Pentane
3	50% Methylene Chloride in Pentane
4	Methylene Chloride
5	5% Methanol in Methylene Chloride
6	20% Methanol in Methylene Chloride
7	50% Methanol in Methylene Chloride
8	5/70/30, Conc. HCl/Methanol/Methylene Chloride

Fractions 5 through 7 will contain the polar species including phenols, alcohols, phthalates, amines, ketones, aldehydes, amides, etc. The distribution of class type between Fractions 5 through 7 will be a function of their polarity and affinity for the silica gel. Some weak acids may elute in Fraction 7.

The very polar species, primarily acids such as carboxylic acids and sulfonic acids, will elute in Fraction 8.

After each fraction is collected, it is transferred to a tared aluminum micro weighing dish for evaporation and gravimetric analysis (Section E.2). Fraction 8 should be dried in a glass container because of its hydrochloric acid content. Each fraction is subsequently analyzed by IR (Section E.3) and, when the quantity is sufficient, LRMS.

Table E-4 lists the MEG categories present in each LC fraction. On the Level 1-Level 2 data presentation charts these are found under "SASS, LAB, LC1 - SASS, LAB, LC8" headings. The Level 1 gravimetric data reported for each LC fraction provide the $\mu g/m^3$ criteria which trigger the decision to conduct Level 2.

The Battelle Run #2 organic extract aliquots were all less than the 100 mg sample preferred for the LC fractionation technique. This has effected the recovery data. In some cases column bleed has produced very high recoveries and in others sample has been lost on the column. In either case this should not affect the Level 2 analysis as adequate procedural blanks have been provided.

Table E-4. MEG Categories Present in Each LC Fraction

LC Fraction	MEG Category Present
1	1. Aliphatic Hydrocarbons (HCs) 2. Halogenated Aliphatic HCs
2	2. Halogenated Aliphatic HCs 15. Benzene, Substituted Benzene HCs 16. Halogenated Aromatic HCs 21. Fused Aromatic HCs 22. Fused Non-Alternant Polycyclic HCs
3	15. Benzene, Substituted Benzene HCs 16. Halogenated Aromatic HCs 21. Fused Aromatic HCs 22. Fused Non-Alternant Polycyclic HCs 23. Heterocyclic Nitrogen Compounds
LC Fraction	MEG Category Present
4	3. Ethers 4. Halogenated Ethers 9. Nitriles 17. Aromatic Nitro Compounds 21. Fused Aromatic HCs 22. Fused Non-Alternant Polycyclic HCs 23. Heterocyclic Nitrogen Compounds 25. Heterocyclic Sulfur Compounds
5	7. Aldehydes, Ketones 9. Nitriles 13. Mercaptans 17. Aromatic Nitro Compounds 18. Phenols 24. Heterocyclic Oxygen Compounds

Table E-4. MEG Categories Present in Each LC Fraction (Continued)

LC Fraction	MEG Category Present
6	5. Alcohols 7. Aldehydes, Ketones 8. Carboxylic Acids, Derivatives 9. Nitriles 10. Amines 18. Phenols 19. Halophenols
7	8. Carboxylic Acids, Derivatives 10. Amines 11. Azo Compounds, Hydrazine Derivatives 18. Phenols 20. Nitrophenols
8	8. Carboxylic Acids, Derivatives 14. Sulfuric Acid, Sulfoxides

E-5 Conclusions

Although the Level 1-Level 2 data presentation charts have not been reproduced in this report (due to their bulk), the data generated during this Level 1 organic analysis activity has been transferred to them from Table E-1. The results of this data assessment are summarized on Table E-5. Table E-5 lists, for LC fractions from each sample, the MEG category numbers requiring Level 2 analysis. The numbers circled are the results of data assessment from the current analytical activity and those uncircled are from Battelle's Level 1 effort in September 1976. In general, volatile or reactive (Categories 10, 21, 22, and 26) have not been retained. This loss of volatile organics, <C13, was also evident from the lack of activity in the conducted gas chromatographic analysis (see Table E-1). This is not unexpected based on the age of the sample. Categories 21 and 22 will be sought for in the sample aliquot taken from each organic extract before Kuderna-Danish concentration.

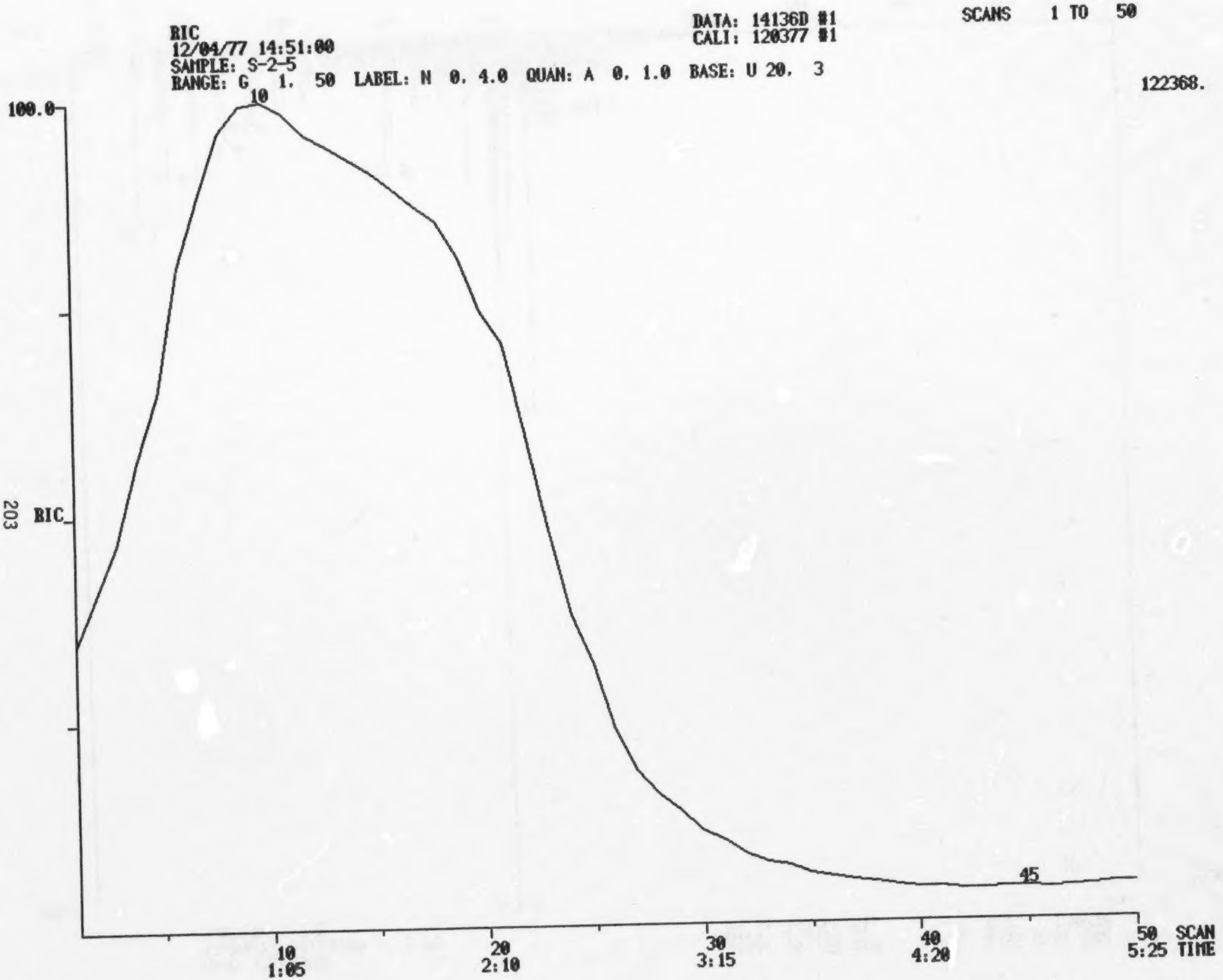
Table E-5. Summary of Required Level 2 Organic Analysis

BCL Sample	LC 1	LC 2	LC 3	LC 4	LC 5	LC 6	LC 7	LC 8
S-2-3, Overflow Bed Material >325 Mesh	26	②,⑯,21, 22 ⑮	16, 21, 22			⑧; ⑩,⑬,⑲,㉓ ⑱	⑧,⑩,⑲,⑳	⑧
S-2-4 Bed Material Ash - 325 Mesh	26	21, 22	21, 22		⑫		⑩,⑲,⑳	
S-2-5 Sludge Sample	㉖	2,⑯,㉑,㉒	⑯,㉑,㉒	㉕	⑫	10,㉓,⑬,⑱	10,⑳,⑧ ⑲	⑧
S-2-6, >27μ Particulate	26	2,⑯,㉑,㉒ ⑮	16,㉑,㉒	㉕		10,㉓,⑱	10,⑳,⑲	⑧
S-2-7, <27μ Particulate	26	2,⑯,㉑,㉒	⑯,㉑,㉒			8, 10, 19,㉓	8, 10, 19, 20	8
S-2-9, FLUE Gas Sample (Level 2 sample not available)	26	2, 16, 21	16, 21	17	12, 17	8, 10, 13, 19, 23	8, 10, 19, 20	8

MEG category numbers are listed. Those circles are indicated from the current Level 1 data. Those uncircled are from the Battelle data.

APPENDIX F

SELECTED GC/MS SCAN



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RANGE: G 1. 50 LABEL: N 0. 4.0 QUAN: A 0. 1.0 BASE: U 20. 3

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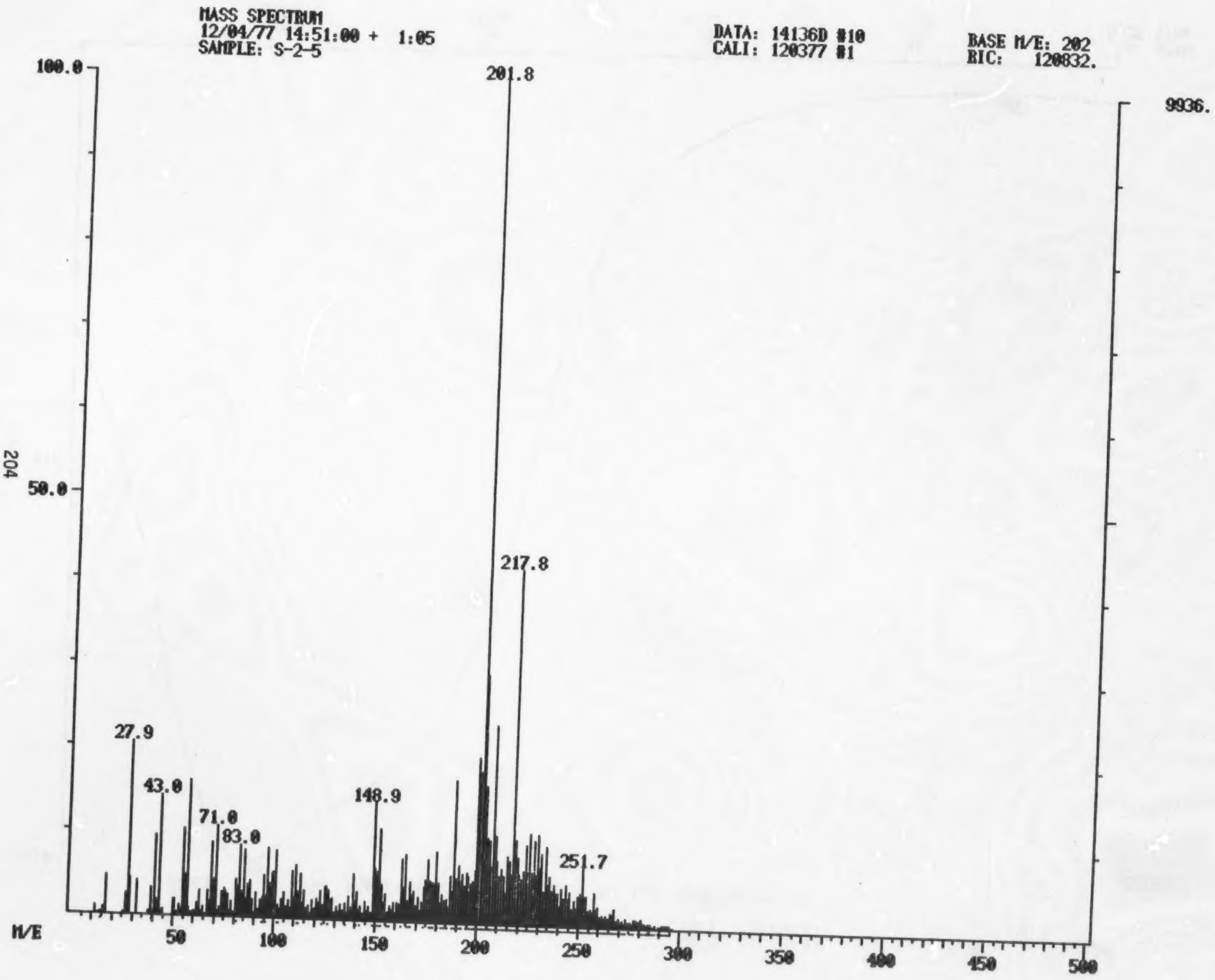
CALI: 120377 #1

SCANS 1 TO 50

122368.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SAMPLE: S-2-5
DATA: 14136D #10
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BASE M/E: 202
RIC: 120832.
100.0
50.0
9936.
201.8
217.8
27.9
43.0
71.0
83.0
148.9
251.7
M/E
50
100
150
200
250
300
350
400
450
500

```
LIBRARY SEARCH                DATA: 14136D #  10          BASE M/E:  202
12/04/77 14:51:00 +  1:05  CALI: 120377 #   1          RIC:      60543.
SAMPLE: S-2-5

22990 SPECTRA IN LIBRARYEP SEARCHED FOR MAXIMUM PURITY
   83 MATCHED AT LEAST 4 OF THE 12 LARGEST PEAKS IN THE UNKNOWN

RANK IND NAME
1 16509  P-TERPHENYL
2 16508  2-PHENYL NAPHTHALENE
3 12501  1,8-DI(1-PROPYNYL) NAPTHALENE
4  9942  PYRENE
5 10416  2-BENZYLNAPHTHALENE

RANK  FORMULA                        M.WT B.PK   PURITY    FIT   RFIT
1  C18.H14                            230  202      405    793    451
2  C16.H12                            204  202      380    878    413
3  C16.H12                            204  202      369    814    408
4  C16.H10                            202  202      357    809    388
5  C17.H14                            218  202      352    768    425

MASS   INTEN       1       2       3       4       5
  39      33                      32      32      32
  41      94
  43     142
  50                                      15
  51                                              18
  55     104
  56      49
  57     160
  63                              18      21      20
  69      88
  70      45
  71     107
  74                                      31
  75                              31              10
  83      85
  85      79
  87                                      44
  88                              41      60
  91                                              49
  97      84
  99                                      11
 100      70                      65      67
 101      94                      99      97
 108                                              73
 109      60                                      60
 110                                       8
 111      63
 113      56
 115                                             119
 122                                       8
 125      38
 126      39      39      39
 127      35               6                      35
 139      54      10                              23
 141      33                                      55
 149     139
 150      63              38              63
 151                              23
 152     108     108     129
 153                      17
 163      74                      82       5
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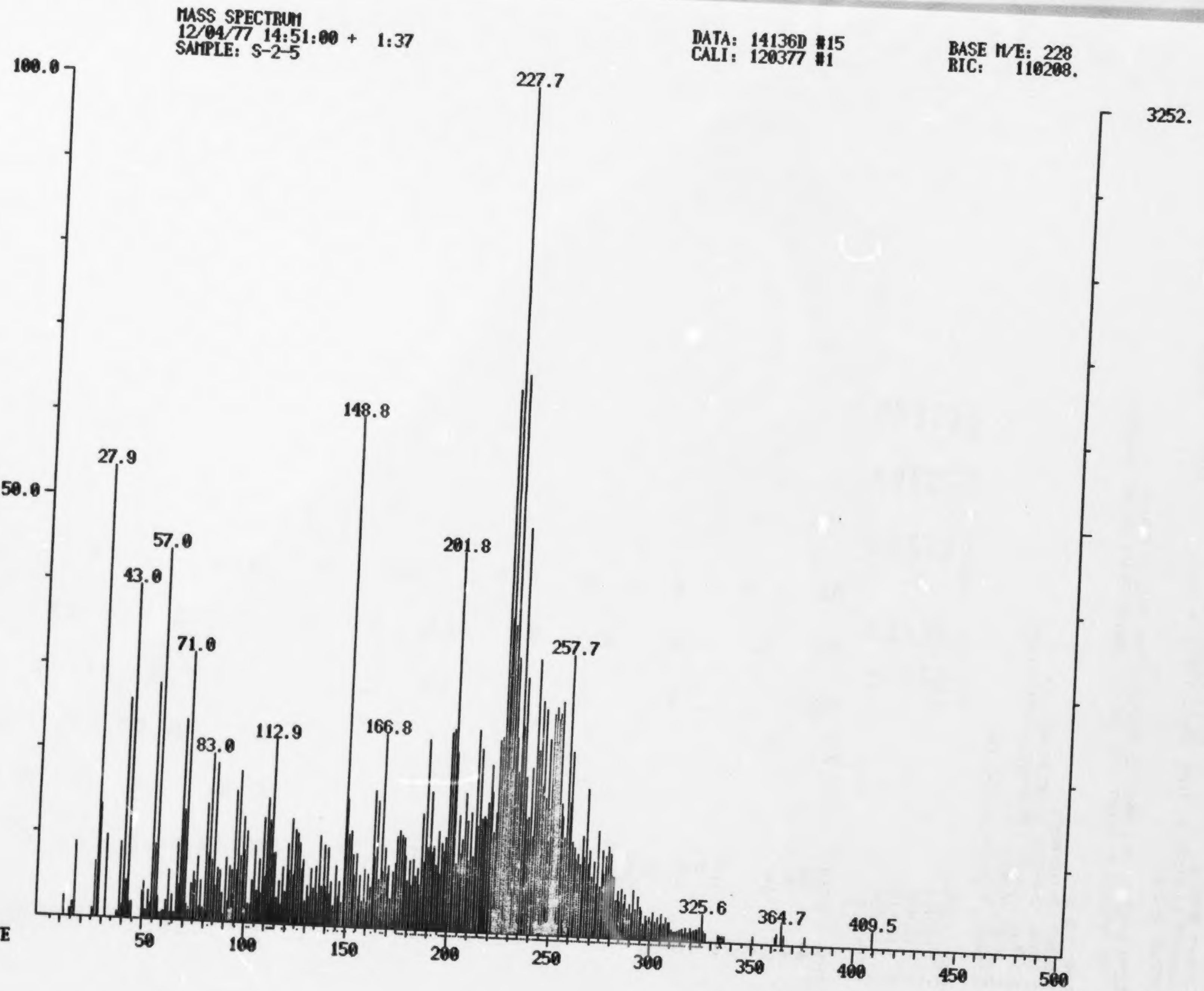
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148.8
27.9
57.0
43.0
201.8
71.0
257.7
83.0
112.9
166.8
325.6
364.7
409.5
M/E
50
100
150
200
250
300
350
400
450
500

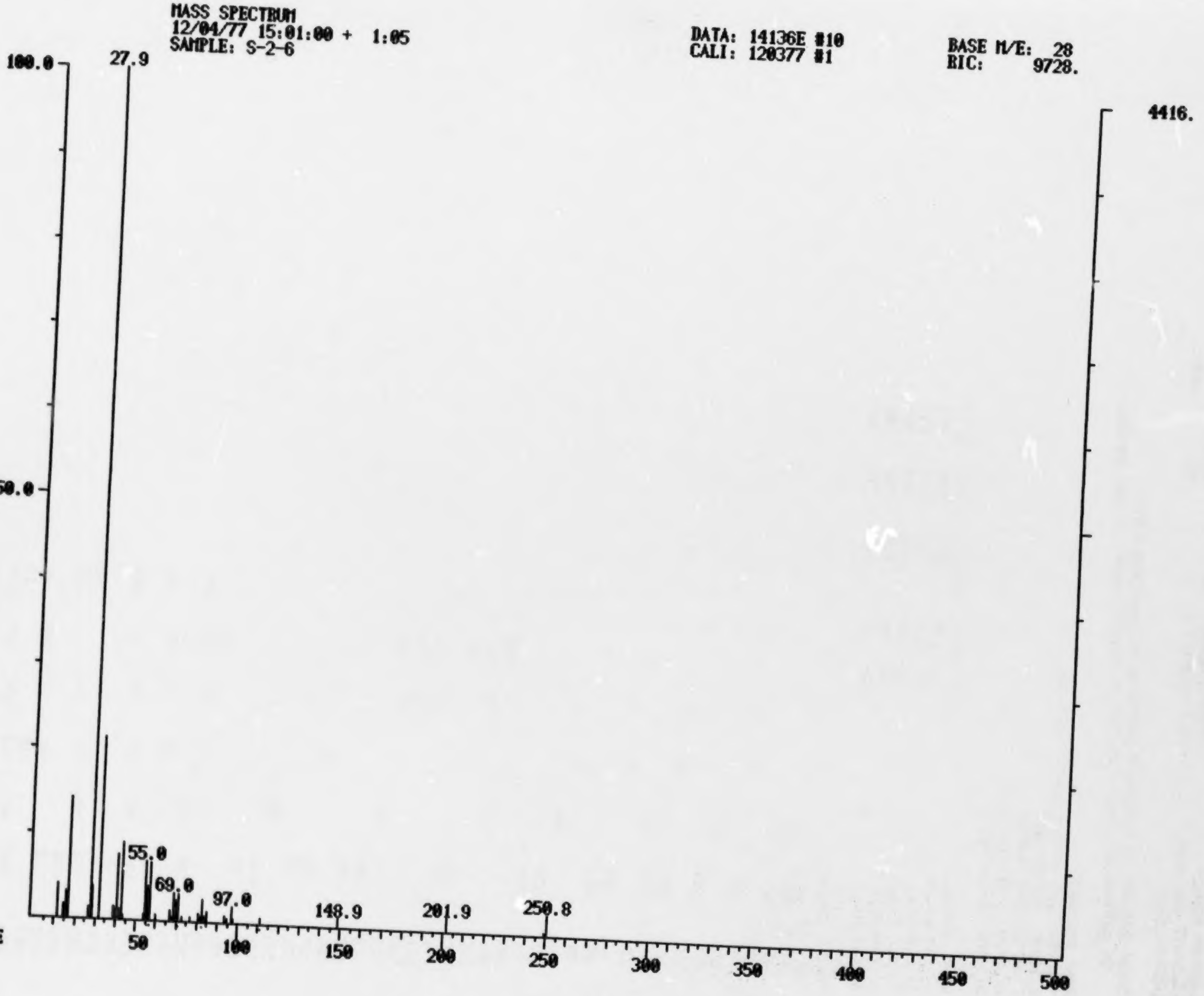
```
LIBRARY SEARCH                  DATA: 14136D #  15          BASE M/E:  228
12/04/77 14:51:00 +  1:37  CALI: 120377 #   1          RIC:      45247.
SAMPLE: S-2-5

22990 SPECTRA IN LIBRARYEP SEARCHED FOR MAXIMUM PURITY
   56 MATCHED AT LEAST 4 OF THE 12 LARGEST PEAKS IN THE UNKNOWN

RANK IND NAME
1 13994  1,5-DITOLYLPENTADIYN-3-ONE
2 10941  O-TERPHENYL
3 10739  O-TERPHENYL
4  2989  O-TERPHENYL
5 16509  P-TERPHENYL

RANK  FORMULA
                                    M.WT B.PK   PURITY    FIT   RFIT
1  C19.H14.O                         258  230      351    685    415
2  C18.H14                           230  230      349    784    386
3  C18.H14                           230  230      344    753    397
4  C18.CL14                          706  230      334    754    408
5  C18.H14                           230  230      319    755    363

MASS     INTEN       1       2       3       4       5
  39                                33
  41       228     255
  43       347     321
  51                        23      51
  55       245
  56               391
  57       386
  63                        24      41
  69       209
  71       278     278
  75                        20      38
  83       175
  85       164
  88                        34      66
  91               198
  95       137
  97       157
 100                                       253
 101               143             202     527
 107                                       107
 111       139
 113       217                     217     217
 114                               249     215
 115                                95     109
 119               201
 123       110
 125       105
 126                        21                      33
 137        94
 139        84                                      21
 143               188
 149       530
 150       132
 151                                       126
 152                57      41      36     125     218
 163       143     142                     142
 165                        42      41     204      41
 167       202
 176       101     102     102      24             102
 177        97
 178                                                65
 189       198     198      44      36             198
 191       154
 200       212             152     116     176     145
 201                       115                      57
 202       406     406     459     406     439     464
 203                       150     150              96
 213       225     168                             155
```



MASS SPECTRUM
12/04/77 15:01:00 + 1:05
SAMPLE: S-2-6

DATA: 14136E #10
CALI: 120377 #1

BASE M/E: 28
RIC: 9728.

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LIBRARY SEARCH                 DATA: 14136E *  10          BASE M/E:   43
12/04/77 15:01:00 +  1:05  CALI: 120377 *   1          RIC:       2739.
SAMPLE: S-2-6

    0 SPECTRA IN LIBRARYEP SEARCHED FOR MAXIMUM PURITY
    0 MATCHED AT LEAST 0 OF THE 12 LARGEST PEAKS IN THE UNKNOWN

MASS   INTEN
  39     167
  41     838
  43    1000
  55     771
  56     445
  57     841
  67     137
  69     368
  70     274
  71     346
  81     109
  83     294
  85     139
  94      87
  95      67
  97     219
 111      72
 149     124
 202     182
 250      52
 251     271
```
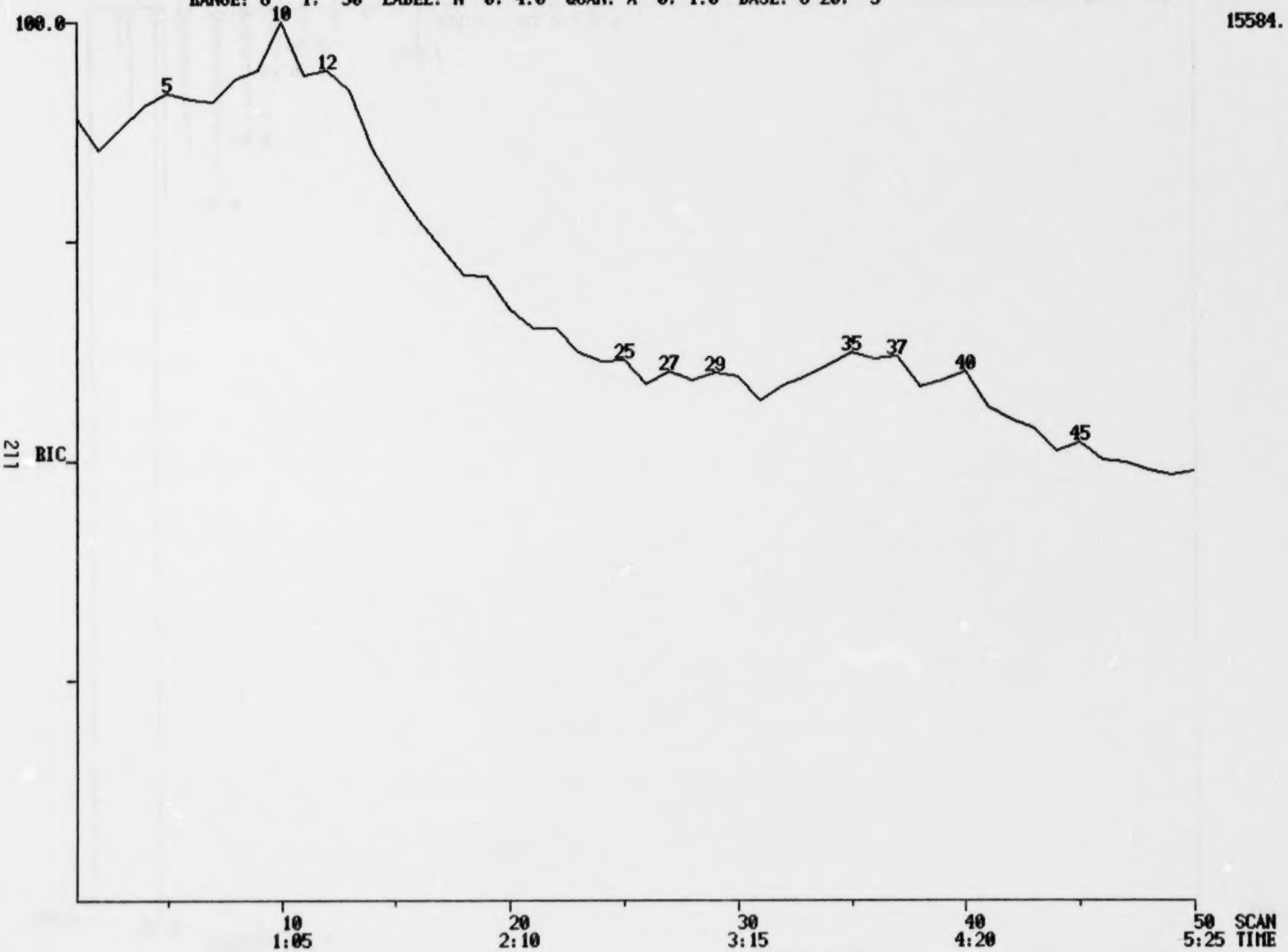

```
LIBRARY SEARCH                  DATA: 14136E *  17          BASE M/E:   43
12/04/77 15:01:00 +  1:50  CALI: 120377 *   1          RIC:        3347.
SAMPLE: S-2-6

22990 SPECTRA IN LIBRARYEP SEARCHED FOR MAXIMUM PURITY
  107 MATCHED AT LEAST 6 OF THE 12 LARGEST PEAKS IN THE UNKNOWN

RANK IND NAME
1  3115  1-OCTADECENE
2 10192  1-OCTADECENE
3 14313  6-FORMYL-3-METHYL-2-OXO-4-HEXENOIC ACID
4 10687  EICOSANOL-1
5  2932  2-CHLORO-4-AMINO-6-ETHYLAMINO-S-TRIAZINE

RANK  FORMULA                    M.WT B.PK   PURITY    FIT   RFIT
1  C18.H36                        252   43      391    868    445
2  C18.H36                        252   43      391    868    445
3  C7.H8.04                       156   43      371    853    434
4  C20.H42.0                      298   43      356    750    451
5  C5.H8.N5.CL                    173   43      352    832    417

MASS   INTEN      1      2      3      4      5
  39     219
  41     886    923    923    762    823    749
  43    1000    968    968   1114   1059   1119
  44                          599           357
  55     827    805    805    692    749   1074
  56     240    423    423           314
  57     845    647    647    966    840    560
  67                          281    267
  68                                 349
  69     675    645    645    618    633    518
  70     295    434    434           334
  71     512    381    381    566    512    647
  81     295                  287    186    234
  82            138    138           403
  83     421    511    511    393    528    352
  84            206    206           177
  85     257    151    151    292    239    368
  94     377
  95     213                  213           199
  97     254    254    254    256    254    269
  98             86     86
 105      91
 109     108                  119
 111     167    167    167    156    167    167
 123      73
 125      79     79     79     79     79     79
 139                           58
 140             39     39            22
 145                                        116
 149     187
 154             26     26            16
 156                          113
 158                                        120
 168             19     19            12
 170     120
 173                                        135
 175      61
 182             14     14             9
 196              8      8             8
 210              9      9             7
 224             16     16             4
 238              1      1             4
 249     143
 250     298
 251     977
 252     146    146    146             9
 266                                   2
 267                                   2
```

RIC
12/04/77 15:09:00
SAMPLE: S-2-7
RANGE: G 1, 50 LABEL: N 0, 4.0 QUAN: A 0, 1.0 BASE: U 20, 3

DATA: 14136F #1
CALI: 120377 #1

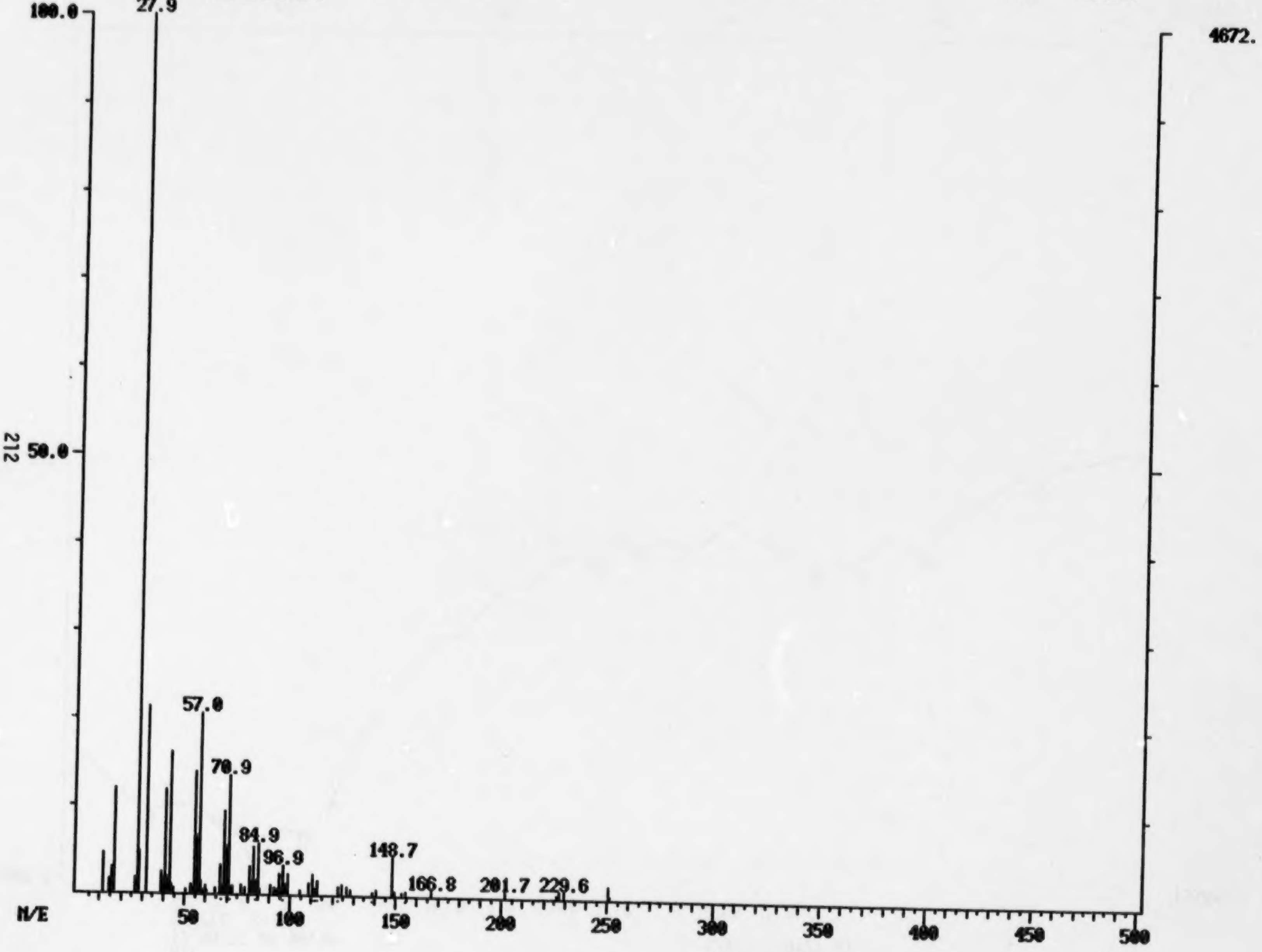
SCANS 1 TO 50



MASS SPECTRUM
12/04/77 15:09:00 + 1:05
SAMPLE: S-2-7

DATA: 14136F #10
CALI: 120377 #1

BASE M/E: 28
RIC: 15152.



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